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CONTENTS

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MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XLI November–December, 1949 No. 6

WESTERN FUNGI—I

Wm. Bridge Cooke

(with 22 figures)

A. Some miscellaneous species from Mount Shasta

1. Peyronelia sirodesmoides Cif. & Frag. In 1927 Ciferri and Fragoso proposed this genus and species for a black mold growing on rotting wood in the Dominican Republic. It was cespitose, black, woolly, had sterile creeping hyphae which were olivaceous, septate, and 3–4.5 μ in diameter. It did not have conidiophores, or these structures were indistinct, being merely the broadened base of the primary conidium. The conidia were black, 1–8 but mostly 2–5 in a chain, fusoid, 3–10-septate, 28–60 $\times$ 7–15 μ (averaging 35–45 $\times$ 9–12 μ), easily separating at a narrow isthmus 2–3 μ in diameter.

On Mount Shasta a fungus was found on dead sticks of *Holodiscus discolor* var. *glabrescens* Heller which fits this description well. The spores in the chains are exogenous, 16–43.5 $\times$ 10–14 μ, 1–5-septate, with the isthmus between the spores 5–6 μ in diameter. In some instances there seem to be rather distinct conidiophores.

The Mount Shasta collection was made on July 16, 1946, on a ridge north of Horse Camp at about 9000 feet elevation, W. B. Cooke *18253*. Despite the wide geographic separation of these two collections there does not seem to be enough difference on which to base a specific segregation.

[Mycologia for September-October (**41**: 493–600) was issued October 31, 1949]

2. ARTHRINIUM BICORNE Rostrup. Material of this species was found forming black sooty areas on dead culms of *Juncus balticus* var. *montanus* Engelm. at Horse Camp, Mt. Shasta, Siskiyou Co., Calif., June 24, 1946, W. B. Cooke *18032*. Mycobiota of North America *280*.

The spores are produced on erect conidiophores up to 200–300 μ long which are divided into a number of short cells from each of which one or two spores are produced on short, lateral processes. The spores are arranged like a row of shingles on the conidiophore. The spores are black, two-horned, smooth, one-celled. Their width from tip of horn to tip of horn is 20–40 μ; the dimensions of the spores exclusive of the horns are 8–13.5 × 13.4–16.7 μ; the horns are 7.5–13.4 × 2.5 μ. The specimen was identified by Lee Bonar.

3. DENDRYPHIUM PINI von Hoehnel. A brown mold on Shasta Fir bark is assigned to this species. On the substratum the mold develops prostrate ropes of brown hyphae. These ropes are 50–75 μ in diam. and are composed of mostly granular incrusted hyphae 1.5–4 μ in diameter, although a few hyphae associated with them are smooth. The smaller hyphae are paler in color. These hyphae are branched and septate. The spores remain in chains until maturity. The chains are 2–20 spores long and are usually branched. The apparently erect conidiophores have roughened walls. The spores are dark brown at maturity, and have both thick and roughened walls. At first they are light brown. They are 1-septate, finally 2–3-septate and measure 10.5–18 × 5.5–7 μ.

According to the description published in Saccardo (Syll. Fung. **22**: 1398), the spores are 16 × 5.5–6 μ, 2–4-septate, finally 4-septate. One wonders if "celled" were intended instead of "septate." *Dendryphium cladosporioides* Ell. & Ev. fits this material well except that it is reported from tomato vines and was collected in Louisiana. It is possible that these three collections may represent the same species.

The Mount Shasta material was obtained from bark of *Abies magnifica* var. *shastensis* Lemmon near Horse Camp, 8000 ft., June 1946, W. B. Cooke *18078*.

4. RAMULARIA MIMULI Ell. & Kell. Spots epiphyllous, becoming confluent, covering entire leaves and even shoots; spores hyaline, 0–3-septate, 18–(25)–33 × 3–4.5 μ.

On *Mimulus tilingii* Regel. In the overflow of a small spring above Panther Creek Meadows, 9000 feet, White Bark Pine Zone, Aug. 29, 1946, W. B. Cooke *18426;* in lower part of Panther

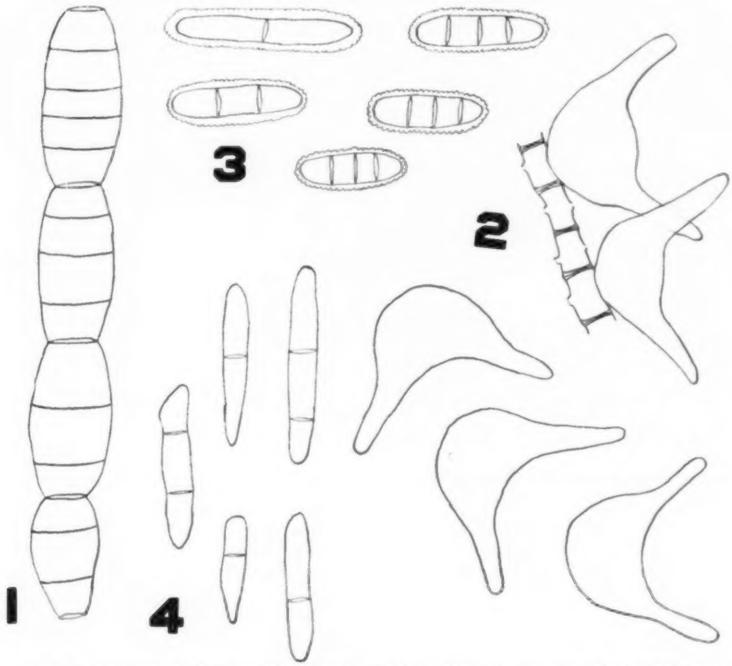


FIG. 1. Spores of *Peyronelia sirodesmoides.* FIG. 2. Spores of *Arthrinium bicorne.* FIG. 3. Spores of *Dendryphium pini.* FIG. 4. Spores of *Ramularia mimuli.*

Creek Meadows, 7000 ft., Shasta Fir Zone, Aug. 15, 1947, W. B. Cooke *20446.* Distributed in Mycobiota of North America No. *221.* Also observed in the large colony of this host around the springs above Horse Camp at 8250 ft. in the White Bark Pine Zone.

Only one species of *Ramularia* has been described on *Mimulus* in North America. It was first reported from Nebraska and the

spores from this collection were described as 30–40 × 3 μ. A later collection from Yellowstone National Park was reported to have larger spores, 40–96 × 4–5 μ. The above collections from Mt. Shasta have generally smaller spores than either of these specimens. It is felt that not enough material is yet available for more than mentioning the existence of this fungus complex.

5. **Ramularia claytoniae** W. B. Cooke, sp. nov. Maculis foliicolis, amphigenis, confluentibus; hyphis conidiophoris gregariis vel fasciculatis, 15–20 × 2 μ, hyalinis; conidiis catenulatis, hyalinis, 20–35 × 1.5–2.5 μ, 0–3-septatis.

Hab. in foliis vivis *Claytoniae sibericae*, Big Springs, prope McCloud, Siskiyou Co., Calif., Jul. 25, 1946. W. B. Cooke **18279.**

Spots on leaves becoming confluent, amphigenous; conidiophores in clusters or appearing singly through the epidermis or occasionally through stomata, up to 20 μ long by 2 μ wide, hyaline; conidia in chains, hyaline, 20–35 × 1.5–2.5 μ, 0–3-septate.

Type collected on *Claytonia siberica* L. in the overflow from the Big Springs of the McCloud River, NW 1/4, S. 14, T. 39 N., R. 2 W., Siskiyou Co., Calif., July 25, 1946, W. B. Cooke *18279*.

So far as either Lee Bonar or the writer can find there is no reference in the literature to a species of *Ramularia* occurring on any member of the Portulacaceae.

6. **Ramularia pentstemonis** W. B. Cooke, sp. nov. Maculis foliicolis, epiphyllis, non vel raro confluentibus; hyphis conidiophoris fasciculatis, 50–200 × 3 μ, hyalinis; conidiis plus minusve catenulatis, hyalinis, non septatis, 8–18 × 3–4.5 μ.

Hab. in foliis vivis *Pentstemonis shastensis*, 1850 m., Mt. Shasta, Siskiyou Co., Calif., Jul. 18, 1947. W. B. Cooke **20207.**

Spots white, scattered, surrounded by red-purple discolored areas; conidiophores hyaline, cespitose, emerging from stomata on upper surface of leaves, 50–300 × 3 μ, breaking up into conidia, or conidia produced terminally, or in chains; conidia hyaline, 8–18 × 3–4.5 μ, non-septate, rare in some spots, common in others. Conidiophores straight to flexuous, septate, some appearing geniculate, some occasionally branched.

Type collected in Wagon Camp Meadows, 5700 ft., Mt. Shasta, Sierra Mixed Conifer Zone, July 18, 1947, W. B. Cooke **20307**. On *Pentstemon shastensis* Keck. Occasionally plants were found to be heavily infected. Excessive humidity near the base of the plants may account for the poor conidial production and the rich

conidiophoral development with some branching to be found on more basal leaves.

No records of a species of *Ramularia* on *Pentstemon* have been found in the various host indices consulted.

7. CYLINDROSPORIUM SMILACINAE Ell. & Ev. and CYLINDROSPORIUM VERATRINUM Sacc. & Wint. On neighboring colonies of the host plants, *Smilacina stellata* (L.) Desf. and *Veratrum californicum* Durand, these two fungi caused heavy infection in the summer of 1947 at Wagon Camp, 5700 ft., Mt. Shasta. Morphologically these fungi appear distinct. Cross-inoculation studies are required to determine whether they represent only different reactions of the same fungus to different hosts.

C. smilacinae has spores 67–90.5 × 2.5–3.5 μ, 1–2-septate, hyaline, more or less curved, produced in large loose masses.

C. veratrinum has spores 87.1–117.3 × 3.5–4.5 μ, 2-septate, cylindric, falcate at one end in most cases, produced in small, compact, barrel-shaped masses which may become confluent for several mm.

The more irregular shape of the spores in *C. smilacinae* may be attributed to their method of production in large, irregular masses which on macroscopic examination of the leaf surface appear as whitish areas in the blackened infected areas of the leaf. The small, barrel-shaped masses of conidia in *C. veratrinum* appear as pink spots on blackened infected areas.

The original description of *C. veratrinum*, quoted in Saccardo, Sylloge Fungorum, describes the spores as being 70–90 μ long. The material from Mt. Shasta noted above has longer spores, as does another collection observed recently. In July 1946, George Nyland obtained at Chinook Pass, Yakima Co., Washington, material assigned to this species by C. G. Shaw, on *Veratrum viride* Ait. (W.S.C. pl. p. *17446*). The spores of this specimen measure up to 170 μ long although some spores fall within the range described by Saccardo and Winter.

This material again brings up the question of polymorphic species of leaf parasites of wild hosts. More extensive series of collections will be necessary to determine whether we are dealing here with only one species or with a group of closely related species.

8. PHYLLOSTICTA MELANOPLACA Thüm. Pycnidia assigned to this species by Lee Bonar were found associated with *Cylindro-*

sporium veratrinum on infected leaves of *Veratrum californicum* collected at Wagon Camp, Mt. Shasta. It has small, bacillar spores 2.5–4 × 1.0–1.5 μ. There is no indication that it is associated with the life cycle of the *Cylindrosporium*.

9. DOTHIORELLA MAGNIFRUCTA (Pk.) Petrak & Sydow (*Phoma magnifructa* Peck). Material referred by Lee Bonar to this species was collected on April 8, 1947 by W. B. and V. G. Cooke, W. B. Cooke *19336*, Mycobiota of North America *276*, on cones of *Libocedrus decurrens* Torr. lying on the ground along the Mud Creek Dam road a mile north of McCloud on the south side of Mt. Shasta.

This species forms small stromata in which 5–20 pycnidia are embedded. The pycnidiospores are cylindric, hyaline, non-septate, 18–22 × 3.2–3.8 μ.

10. SELENOPHOMA LINICOLA T. C. Vanterpool. Pycnidia on the surface of stems the summer following the death of the above-ground portions of the host. Spores lunate, hyaline, non-septate, 16–22 × 2.9–3.5 μ.

On dead stems of *Iliamna bakeri* (Jeps.) Wiggins in the chaparral along the Shasta Snowline Highway, 4500 ft., Mt. Shasta, July 12, 1946, W. B. Cooke *18233*.

Morphologically this material is too close to *S. linicola* to establish it as a distinct species, although reference to collections of material published in the literature gives a precedent for such treatment. Cross-inoculation studies have not been made on it and it does not appear to be pathogenic since it was found on year-old litter.

11. SEPTORIA LUNELLIANA Sacc. Several plants of *Carex fracta* Mkze. at MacBride Springs Public Camp, 5000 ft., Mt. Shasta, were found to be heavily infected with this species on July 3, 1947, W. B. Cooke *20226*. The spots are white, surrounded by brown discolored areas which become confluent for large areas on the leaf. Pycnidia are scattered in the spots. The spores are 3-septate, hyaline, 55–77 × 3–3.5 μ. This specimen was identified by Roderick Sprague and distributed as no. *278* in Mycobiota of North America.

12. SEPTORIA AROMATICA Kabat & Bubak. Lesions at first yel-

low, then blackened with areas in which black pycnidia are located. These areas are not usually confluent and the pycnidia are scattered in them, but whole leaf segments may appear to become blackened. Pycnidia black, 75–100–150 μ in diameter. Spores straight to curved, 1–3-septate, 63.5–80.4 × 3.5–4 μ, hyaline.

On *Ligusticum grayi* C. & R. along Panther Creek below the meadows, 7000 ft., Mt. Shasta, Aug. 15, 1947, W. B. Cooke *20441*.

No species of *Septoria* were found listed on *Ligusticum grayi* nor on related species from Western North America and a check was made on those species reported in Saccardo on umbelliferous hosts. From the sixty-four names found, seven species fall into or near the spore-size range noted above. The description of the species to which this collection is assigned fits this collection better than any of the other six.

13. **Phyllosticta crustosa** Lee Bonar & W. B. Cooke, sp. nov. Maculis hypophyllis, atris, confluentibus et totum folium saepe occupantibus; hyphis atris, in epidermide crustosis; pycnidiis globosis, sparsis vel gregariis, subepidermalibus, 90–130 μ diam., pallide brunneis; ostiolo non papillato, poroideo; pycnidiosporulis bacillaribus, unicellularibus, hyalinis, 5.7 × 0.5–0.7–1 μ; conidiophoris simplicibus, hyalinis, 8–13 μ longis.

Hab. in foliis vivis *Kelloggiae galioidis*, 1850 m., Sisson Southern Trail, Mt. Shasta, Siskiyou Co., Calif., Aug. 22, 1947. W. B. Cooke **20471.**

Hypophyllous as blackish spots on leaves, distinct specks becoming confluent and often covering the entire leaf; blackening due to closely packed, sinuous dark hyphae in epidermal cells which form a black crust; pycnidia scattered, subepidermal, arising beneath the crust, light brown in color; ostiole poroid, non-papillate, conidia bacilliform, 1-celled, hyaline, 5–7 × 0.5–0.7–1 μ; conidiophores simple, hyaline, 8–13 μ long.

Type collected on leaves of *Kelloggia galioides* Torr., W. B. Cooke **20471**, Sisson Southern Trail, Mt. Shasta, Siskiyou Co., Calif., Aug. 22, 1947. A second collection is filed at the Herbarium of the University of California: Rock Creek, 1.6 miles S.E. of Dean's Valley, S.E. of Meadow Valley, Plumas Co., Calif., Aug. 11, 1947. C. R. Quick *47–109*.

The fact that *Kelloggia* leaves were infected with some sort of disease was noted during the several years that the writer hiked Mount Shasta trails. However, after several futile attempts, fruiting material of the fungus was collected only in 1947.

Records of fungi on *Kelloggia* are not frequent and no record of a fungus such as this has been found in the literature. The writer is indebted to Lee Bonar for the above English description.

In 1889 Ellis and Everhart described *Hainesia borealis* from material of diseased *Galium boreale* L. collected at Kamloops, British Columbia, by J. Macoun. Material of this species was collected by R. Sprague, G. W. Fischer and J. P. Meiners on *Galium boreale* below Teton Pass in Teton Co., Wyoming near the Idaho line on Aug. 13, 1948. This material is housed in the Herbarium of the Dept. of Plant Pathology, State College of Washington as No. *17452*. The disease symptoms of this specimen look very much like those on young specimens of the Mount Shasta material but the spores are produced in acervuli rather than in pycnidia.

Such a situation was noted by C. L. Shear and B. O. Dodge in *Pezizella lythri* (Desm.) Shear & Dodge. In a paper entitled "The life history and identity of '*Patinella fragariae*,' '*Leptothyrium macrothecium*,' and '*Peziza oenotherae*' " (Mycologia **13**: 135–170, 1921), they recognized under *Pezizella lythri* two types of imperfect stages. The first of these was *Hainesia lythri* (Desm.) v. Höhn. It represented the conidial stage, and thirteen synonyms were listed for it. The second of these, the pycnidial stage, was *Sclerotiopsis concava* (Desm.) Shear & Dodge under which twelve earlier names were placed in synonymy. It is possible that *Hainesia borealis* Ell. & Ev., which has spores borne in acervuli and measuring $5–7 \times 0.5–1\ \mu$, and *Phyllosticta crustosa* Bonar & W. B. Cooke, which has spores borne in pycnidia and measuring $5–7 \times 0.5–1\ \mu$, are similarly two types of imperfect stage of an as yet unidentified or unknown ascomycetous fungus.

14. *Hysterium acuminatum* Fr. var. *alpinum* Rehm. Rehm referred material collected on *Pinus cembra* in the Tyrol to this variety in his Ascomycetes No. *125*. Three collections from Mount Shasta have been referred to this category by the writer and by Lee Bonar. They agree well with the description given in Saccardo (Syll. Fung. **2**: 746. 1883). This species has been collected on bark of *Tsuga mertensiana* (Bong.) Sarg., W. B. Cooke *8663*, Aug. 24, 1937, at Panther Creek; on wood of *Abies magnifica* var. *shastensis* Lemmon, W. B. Cooke *10148*, June 23, 1938, at

Horse Camp; and on boards of *Pinus ponderosa* Dougl. at Horse Camp, 8000 ft., W. B. Cooke *18228, 18274,* July 1946.

The hysterothecia are 0.5–0.8 mm. long, dull black, superficial, filled with asci in all stages of development, 105–120 × 7–8 μ; the spores are brown, smooth, uniseriate, constricted at the middle septum, 13–15 × 6 μ. The spores are at first hyaline, develop a central septum before pigmentation starts, have most of their pigmentation before the second and third septa develop, and are finally dark-brown and 4-celled.

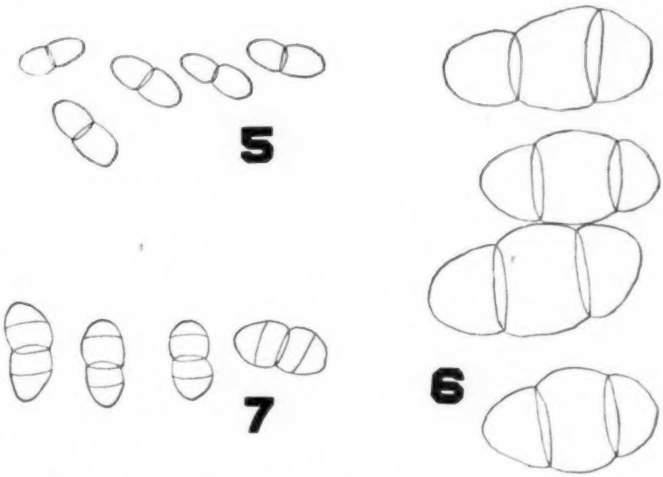


FIG. 5. Spores of *Dimerium alpinum.* FIG. 6. Spores of *Exosporium pedunculatum.* FIG. 7. Spores of *Hysterium acuminatum* var. *alpinum.*

15. **Dimerium alpinum** W. B. Cooke, sp. nov. Mycelio amphigeno, atrobrunneo, ex hyphis repentibus, ramosis, 3.5–10.8 μ diam.; peritheciis ovoideis, membranaceis, non papillatis, levibus, atris; ascis cylindraceis, 43.5–58 × 8.7–10.2 μ, aparaphysatis, octosporis; ascosporis uniseriatis vel biseriatis, ellipsoideis, 1-septatis, medio constrictis, brunneis, 11.6–13.2 × 4.35–5.8 μ.

Hab. ad folia *Pentstemonis menziesii* var. *davidsonii,* 3000 m., Mt. Shasta, Siskiyou Co., Calif., Jul. 30, 1946. W. B. Cooke **18314**.

Perithecia black, without beak, in a dense mycelial mat, 200–250 μ in diameter; hyphae of subiculum black, with thick cuticle, 3.5–10.8 μ in diameter, loosely interwoven, well branched, septate, opaque, sometimes densely encrusted with foreign matter apparently caught in the gelatinous cuticle which is brown in color; asci 43.5–

58 × 8.7–10.2 μ; ascospores brown, 2-celled, 4.35–5.8 × 11.6–13.2 μ, constricted at the septum, uniseriate to biseriate, thick-walled, lower cell slightly smaller than upper cell in some asci.

Forming black crusts usually on lower surface of leaves of *Pentstemon menziesii* var. *davidsonii* (Greene) Piper, sometimes blackening whole plants or portions of plants which grow mat-like in protection of rocks in the White Bark Pine and Alpine Zones, Mt. Shasta, Siskiyou Co., Calif. **Type collection**: W. B. Cooke **18314**, July 30, 1946, 9000 ft., Mt. Shasta. Other collections from the southwest side of Mt. Shasta between 9000 and 10,000 feet in the White Bark Pine and Alpine Zones include W. B. Cooke numbers *8601,* July 28, 1937; *10252,* July 28, 1939; *15711,* Aug. 14, 1941; and *20479,* Aug. 28, 1947.

Collections of material of this species made prior to 1946 and in 1947 were mostly immature. The 1946 collection showed mature ascus and spore characters well. If it seems peculiar that a sooty mold should grow at such high altitudes, it should be remembered that moisture and relative humidity are very high under the snow pack which covers the higher slopes of the mountain for more than six months of normal years. Temperature conditions under the snow pack are not well known but are such that some fungus growth is permitted during the existence of the pack. The moisture and humidity conditions are high enough to satisfy the requirements of large numbers of "micromycetes," most important of which are the brown felt or smothering fungi, *Neopeckia coulteri* on pines and *Herpotrichia nigra* on firs and hemlock.

16. **Cryptosporella acerina** L. E. Wehmeyer, sp. nov. Stromatibus sub cortice nidulantibus discoideis idque pustulatim elevatibus, discis densis, atris, rotundis vel ellipticis erumpentibus; peritheciis 5–10, in cortice immersis, globosis vel elongatis, atro-brunneis, 300–400 × 200–350 μ diam.; ostiolis elongatis, 100–200 μ diam., in discum per peridermium erumpentibus; ascis numerosis, clavatis, basibus deciduis, tenuibus, 45–70 × 12–14 μ, octosporis; ascosporis biseriatis, unicellularibus, hyalinis vel late fusoideis, 10–12.5 × 4.5–5 μ.

Hab. in cortice ramulorum emortuorum *Aceris glabri,* 2000 m., Mt. Shasta, Siskiyou Co., Calif., Aug. 8, 1947. W. B. Cooke **20413.**

On surface as longitudinally seriate, crowded, rounded or elliptic, black, wrinkled or rugose discs which are erumpent through longitudinal ruptures of the periderm. These discs have a tough, rubbery texture, the edges are emarginate, raised, curled inward or

wrinkled. The discs may or may not contain several short-cylindric, punctate ostioles. The disc originates just beneath the periderm as a parenchymatic mass of dark brown, thick-walled, coarse-celled ectostroma which ruptures the periderm. The perithecia, which are formed in clusters of 5–10 beneath the discs, in the bark cortex, are 300–400 × 200–350 μ in diameter, globose or radially elongate from crowding, and have stout ostiolar necks, 100–200 μ in diameter, which penetrate the overlying ectostroma. The walls of the perithecia and ostioles are 15–30 μ thick and consist of an outer layer of coarse, dark brown, compressed parenchyma cells and a thin layer of light-colored finer hyphae. Asci numerous, clavate, soon deciduous at the base and free in the perithecium, thin-walled with a refractive ring in the apex, 45–70 × 12–14 μ. Spores biseriate, one-celled, hyaline, ellipsoid to broad fusoid, 10–12.5 × 4.5–5 μ.

Type collection: on *Acer glabrum* Torr., Sisson Southern Trail Spring, 6000 ft., Mt. Shasta, Aug. 8, 1947, W. B. Cooke **20413**.

This species differs from all other described species of *Cryptosporella* in the large black erumpent discs and in the smaller spores. There are evidences of cavities in the upper portions of the ectostroma, in which conidia may have been formed in the early development of this tissue.

The writer is indebted to L. E. Wehmeyer for studying this and the following species, for preparing the English diagnoses and the notes and the accompanying illustrations of these two species.

17. **Massarinula lignorum** L. E. Wehmeyer, sp. nov. Peritheciis parenchymaticis, crassis, atris, laxe gregariis, in ligno immersis, 600–1000 × 300–500 μ; ostiolo minuto, papillato; ascis late-clavatis, 105–125 × 20–25 μ; paraphysibus numerosis, filiformibus, persistentibus; ascosporis biseriatis, hyalinis, fusoideo-ellipsoideis, plus minusve inaequilateralibus vel curvatis, 1-septatis, 4-guttulatis, medio-constrictis, 35–44 × 10–12 μ, apicibus contractis, plus minusve obtuse rotundatis.

Hab. in ramulis emortuis *Aceris glabri*, 2000 m., Mt. Shasta, Siskiyou Co., Calif., Aug. 8, 1947. W. B. Cooke **20403**.

On surface as rather thickly scattered, circular to elliptic, black pustules with a minute, papillate, central ostiole. Perithecia flattened ellipsoid, 600–1000 × 300–500 μ, buried in the surface layers of the wood and erumpent through the ruptured overlying fibers. Perithecial walls of very coarse, black-walled parenchyma, thin (20–30 μ) below, much thicker (50–100 μ) on the upper exposed surface. Asci broadly clavate, wall somewhat thickened above, 105–125 × 20–25 μ, imbedded in a mass of filiform, hyaline, per-

sistent paraphyses. Spores biseriate, hyaline, fusoid-ellipsoid, somewhat inaequilateral or curved, two-celled but 4-guttulate, possibly becoming 4-celled at full maturity, constricted at the central septum, ends tapered and somewhat bluntly rounded, 35–44 × 10–12 μ.

Type collection: on *Acer glabrum* Torr., near Sisson Southern Trail Spring, 6000 ft., Mt. Shasta, Aug. 8, 1947, W. B. Cooke **20403**.

There exists a large group of species, all of which are very similar in spore form and perithecial structure and to which the species just described belongs. They have fusoid, hyaline, spores with a characteristic "biconic" form, strongly constricted at the middle, swollen on both sides of this septum and tapered toward the ends, usually inaequilateral or curved. These spores are usually 2-celled at first then 4-guttulate and then 4-celled. In some cases they may turn brown at extreme maturity. They may or may not have a gelatinous envelope, which in the writer's opinion is unimportant but it is used as a diagnostic character of the Massariaceae. The color and septation of the spores vary with maturity and with the species, but it is often difficult to distinguish between these two factors because of overlapping types. As a result, these fungi, though closely related, are to be found in a number of genera. They are related on the one hand to certain species of *Didymella* and the genus *Massarinula* in the Massariaceae and on the other hand to certain species of the genus *Metasphaeria* and *Massarina*.

The perithecia have a structure similar to that common in the Massariaceae, with numerous persistent paraphyses. The fungus here described is very similar to *Massarina eburnioides* Sacc., *M. pomacearum* Höhn. and *M. corni* (Fckl.) Sacc. Höhnel (Ann. Myc. **15**: 361. 1917) has already noted the similarity of these species and their relation to *Metasphaeria*, when the gelatinous envelope about the spore is lacking. *Massarinula lignorum* has the same large spores, but these have no gelatinous envelope and they remain, for the most part, two-celled. Although they possess four large guttulae, and a few cases were seen in mounts in Amann's solution where the spore protoplast seemed to be four-parted, most spores were definitely two-celled as seen in this medium.

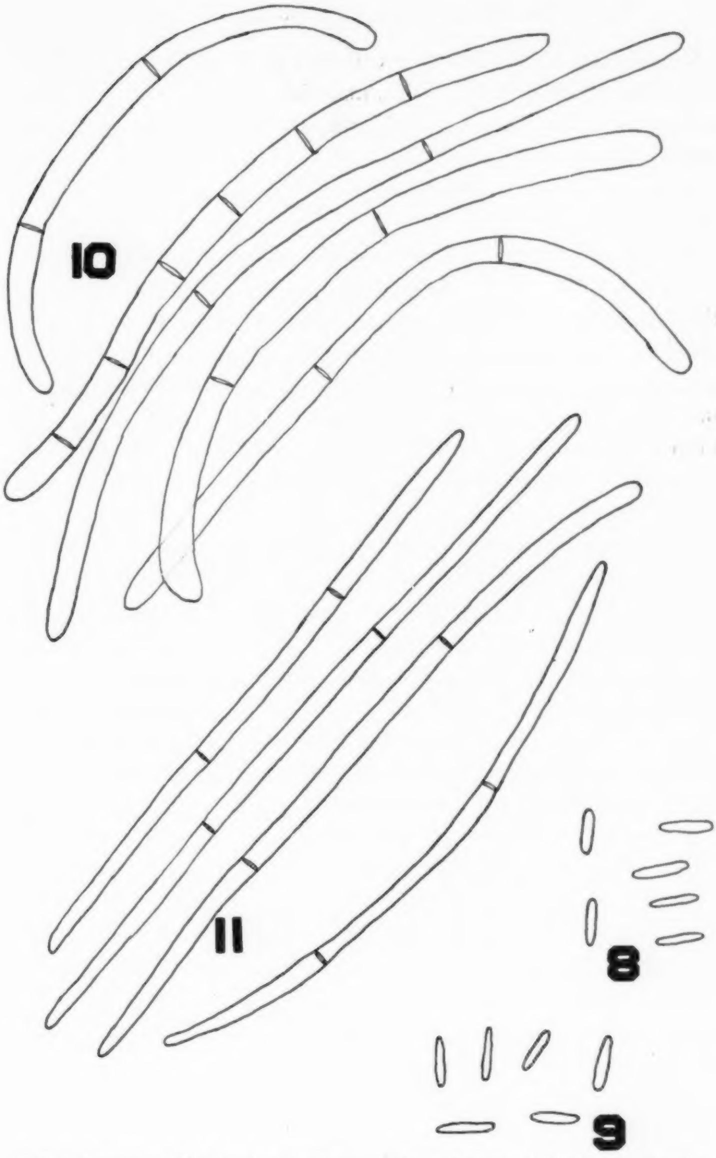


FIG. 8. Spores of *Phyllosticta crustosa.* FIG. 9. Spores of *Hainesia borealis.* FIG. 10. Spores of *Cylindrosporium veratrinum.* FIG. 11. Spores of *Cylindrosporium smilacinae.*

B. SOME SPECIES ASSOCIATED WITH SAMBUCUS

On July 25, 1946, the writer collected at Bear Springs, 5000 ft., Mt. Shasta, Siskiyou Co., Calif., material identified by comparison with material distributed from Northport, Washington, by Science Service, Ottawa, as *Exosporium sambuci* Tracy & Earle. The Mt. Shasta specimen was distributed as no. *208* in the "Mycobiota of North America."

Recently in checking over material in that part of the C. V. Piper collections housed in the Herbarium of the Botany Department of the State College of Washington, specimens were found of *Brachysporium puccinioides* E. & E. and *Brachysporium pedunculatum* Ell. & Ev. from Pullman, Washington. These specimens compared favorably with the material from Mt. Shasta, Northport, and a more recent collection from the top of the White Bird Grade, 4400 ft., Idaho Mountain, Idaho Co., Idaho, W. B. Cooke *23807*, June 12, 1948.

In order to clarify the status of these specimens material of *Exosporium* and *Brachysporium* species on *Sambucus* species was kindly loaned by B. B. Kanouse, University of Michigan; H. M. Fitzpatrick, Cornell University; D. P. Rogers, New York Botanical Garden; J. A. Stevenson, Mycological Collections, Beltsville, and G. W. Martin, State University of Iowa. In addition to specimens of these species, material of *Heterosporium* and *Helminthosporium* was obtained. It was thought that since *Brachysporium* had been confused with *Exosporium* it was possible that some collections filed under these genera might belong to this complex.

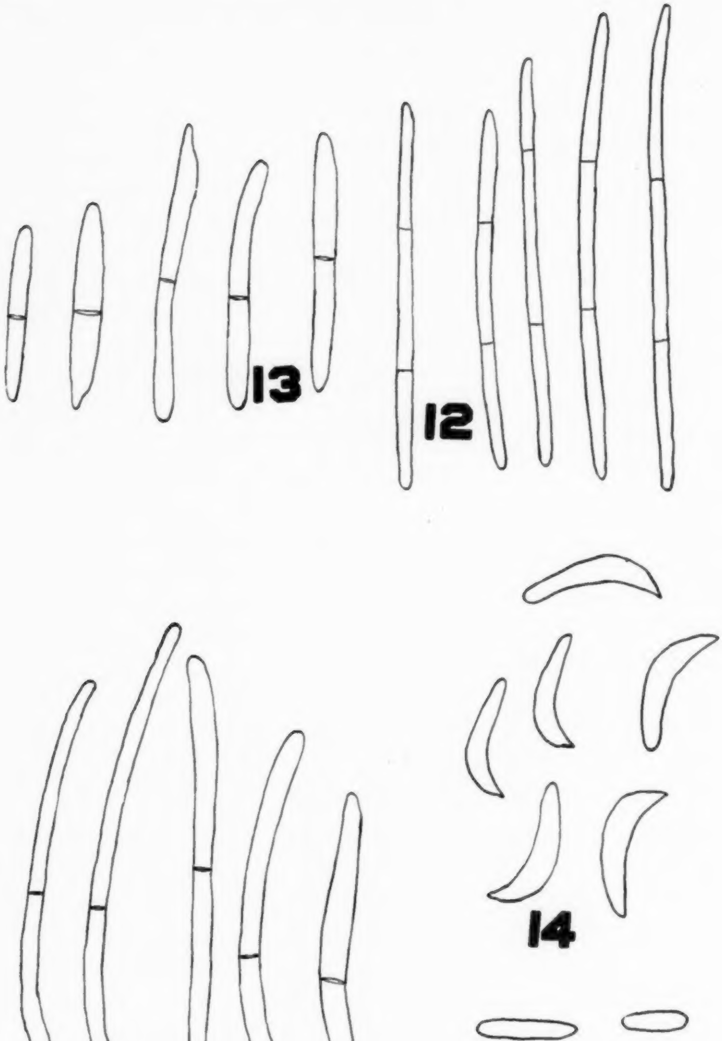
Exosporium was first described by Link (Mag. Ges. Naturf. Fr. Berlin **3**: 9. 1809). It was used again by Link in 1825 in Vol. 6, part 2, of Wildenow's 4th edition of Linnaeus' Species Plantarum. Fries reduced the species of *Exosporium* to synonymy in *Helminthosporium* since he considered these species as only stromatic members of this genus. If it is noted below how later workers have confused *Brachysporium*, a segregate of *Helminthosporium*, with *Exosporium*, one can see how Fries could have placed *Exosporium* in *Helminthosporium*.

In 1869, Fuckel (Symb. Myc. p. 372) applied the name *Cryptocoryneum* to fungi of this type. Lindau, in Rabenhorst's Krypto-

gamen Flora, ed. 2, Vol. 9, p. 362, 1910, used *Exosporium* and indicated that this was in accord with von Höhnel's treatment. In 1923, von Höhnel accepted both genera and added *Phanerocoryneum* to the group. He distinguished them by assigning to *Exosporium* erumpent, cartilaginous species, to *Phanerocoryneum* species which were superficial, with longish, loosely arranged conidia, and to *Cryptocoryneum* superficial species with long, cylindric, many-celled conidia which occur in dense bundles. Clements and Shear, Genera of Fungi, 1931, indicate that the difference between *Cryptocoryneum* and *Exosporium* is that in the former the sporodochia are superficial, in the latter they are erumpent.

EXOSPORIUM SAMBUCI Tracy & Earle. In 1898 Tracy and Earle distributed as No. *1104* in their "Plants of Colorado" under this name a fungus collected on *Sambucus melanocarpa* along the La Plata River at 10,000 feet, Durango Co., Colorado, by C. F. Baker, F. S. Earle and S. M. Tracy. In this material the sporodochia are visible as black elliptical spots under splits in the bark which may have originated at the lenticels. The sporodochia develop on or below the cambium. The lesions are 0.5–3 × 0.1–0.5 mm. They may eventually become confluent although this is not particularly evident in the two specimens of the type collection from the New York Botanical Garden. The large size is attributed to the large sporodochium rather than to the confluence of more than one sporodochium. The sporophores are densely packed together, 5–6 μ in diameter, septate, yellowish, and are often deciduous, remaining attached to the spores, even after rough treatment in making crush mounts. The conidia are ovate to obovate, yellow-brown, usually 3-septate (although 2-septate spores are seen in every mount), usually constricted at the septa, in spite of the fact that in the original description it is stated that they are not constricted, and measure 40–44 × 17–20 μ.

Brachysporium sphaerocolum F. E. Clements, nom. nud. Material assigned to this species was collected by F. E. and E. S. Clements at 2500 m. (7500–8000 ft.) in Larkspur Dell, Colorado, on July 11, 1905. The specimen was obtained from *Sambucus microbotrya* in a *Picea-Pseudotsuga* Association. It was distributed in Clements' "Cryptogamae Formationum Coloradensium,"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in which it was not described, and was loaned to me by Mr. Stevenson. The label of this specimen merely contains habit and habitat information in Latin. Microscopic examination indicates that this specimen is *Exosporium sambuci* Tracy and Earle. Thus two specimens are on record of *Exosporium sambuci* and both are from Colorado.

BRACHYSPORIUM PUCCINIOIDES Ell. & Ev. C. V. Piper collected material at Pullman, Whitman Co., Washington, W.S.C. *170463*, which Ellis assigned to this species. However, according to a note on the type packet at the New York Botanical Garden, Ellis and Anderson already had assigned this name to a species of *Macrosporium*. Thus Ellis changed the name to *Brachysporium pedunculatum* Ell. & Ev. Piper's specimen was distributed to several herbaria before the correction was made. The earlier name is a *nomen nudum* and should be used only in synonymy with the following species:

Exosporium pedunculatum (Ell. & Ev.) W. B. Cooke, comb. nov.

Brachysporium pedunculatum Ell. & Ev., Proc. Acad. Phil. 1895, p. 440. 1895.

Brachysporium puccinioides Ell. & Ev. in herb., *nomen nudum.*

This species is based on material collected by C. V. Piper on March 24, 1894, at Pullman, Whitman Co., Wash., on dead branches of *Sambucus glauca* Nutt. Piper's specimen, the type, was assigned the number *316*, and duplicates have been observed from the New York Botanical Garden, Mycological Collections, and the Herbarium of the State College of Washington, *170463*.

This species, too, has spores which are produced on sporodochia. These structures, in dry specimens, are hard, black, sclerotic masses. They appear, in microscopic examination, as rather large *Puccinia* pustules. (This accounts for the first name assigned the species by Ellis.) The sporodochium is produced on or under the cambium and breaks through the bark at lenticels, at weak points in the bark, or in elongate linear areas in the internodes. These sporo-

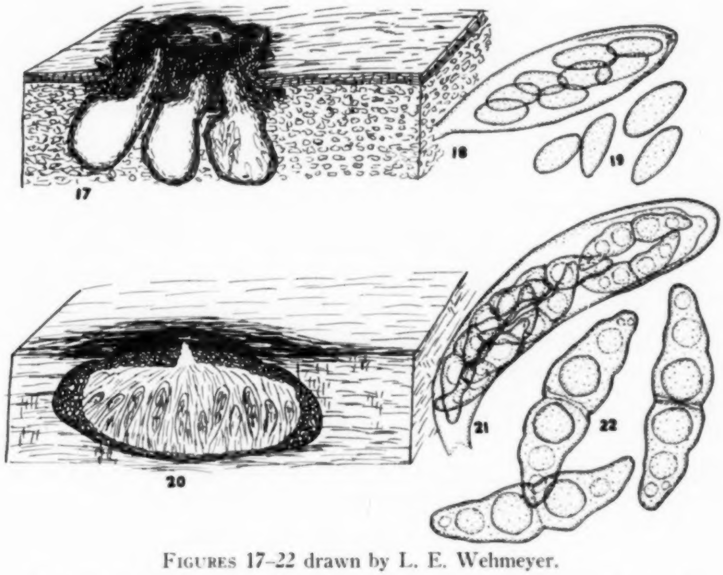
FIG. 12. Spores of *Septoria lunelliana*. FIG. 13. Spores of *Ramularia claytoniae*. FIG. 14. Spores of *Selenophoma linicola*. FIG. 15. Spores of *Ramularia pentstemonis*. FIG. 16. Spores of *Septoria aromatica*.

dochia may become confluent. Upon making fresh water-mounts the sporophores may become detached along with the spores, making them appear "pedunculate." The sporodochia in the Revelstoke collection measure 0.25–0.5 mm. in diameter. Confluence may increase this size to a half centimeter or more in length. The conidiophores are 12–15 × 6–7 μ, septate, yellowish. The spores are produced terminally. The conidiospores are 22–30 × 12–15 μ in the type collection, 25–36 × 14.5–18 μ in the Revelstoke collection, and the other collections examined have spores of similar or intermediate dimensions. The spores are two-septate, brown to dark brown, usually constricted at the septa, with a swollen central cell which gives them a blunt fusiform to barrel shape. Some of the spores are flattened on one side and this, with the swollen central cell, gives the spore a "*Curvularia*" aspect. The original description, and Ellis' notes on the type packet at the New York Botanical Garden, indicate that Ellis did not notice the constrictions at the septa. All the spores observed were two-septate. In addition to the Pullman specimen, specimens have been examined from Revelstoke, 1500 ft., British Columbia, collected Sept. 25, 1930 by J. R. Hansbrough *158* (NYBG); Northport, Pend Oreille Co., Wash., Sept. 24, 1929, A. W. McCallum, distributed by Herbarium, Division of Botany, Ottawa, Canada (Myc. Coll., U. Mich., U. Calif.); Cedar Mt., Latah Co., Idaho, July 1898, C. V. Piper *691;* Herb. St. Coll. Wash. *170295;* Mt. Idaho, Idaho Co., Idaho (WBC); Mt. Shasta, Siskiyou Co., Calif. (WBC, Mycobiota of North America *208*); and San Antonio Canyon near Claremont, Los Angeles Co., Calif. Pacific Slope Fungi, dist. by C. F. Baker, collected Oct. 10, 1903 by C. F. Baker (NYBG). All have the same microscopic features although there is some variation in size and degree of confluence of the sporodochia.

Brachysporium is a member of the Dematiaceae and thus is non-stromatic or moniliaceous in fruiting habit. Since *Exosporium* has sporodochia it is placed in the Tuberculariaceae. Since material of *Exosporium pedunculatum* Ell. & Ev. in all mounts shows spores produced on sporodochia it should be placed in the Tuberculariaceae rather than in the Dematiaceae. At present, *Exosporium* is the best genus in the Tuberculariaceae in which to place it. It differs from *Exosporium sambuci* Tracy & Earle, known so

far only from two Colorado collections, in its smaller, three-celled spores.

Link established the genus *Helminthosporium* in 1809. Persoon in 1822 used it in essentially the same sense. The concept of the genus or its description has become enlarged until today it is used in the sense of Lindau, Vol. 9, ed. 2, of Rabenhorst's Kryptogamen Flora. Dreschler (Graminicolous species of *Helmintho-*



FIGURES 17–22 drawn by L. E. Wehmeyer.

FIG. 17. Section through perithecial stroma of *Cryptosporella acerina*. FIG. 18. Ascus of *Cryptosporella acerina*. FIG. 19. Ascospores of *Cryptosporella acerina*. FIG. 20. Section through perithecium of *Massarinula lignorum*. FIG. 21. Ascus of *Massarinula lignorum*. FIG. 22. Ascospores of *Massarinula lignorum*.

sporium, Jour. Agr. Res. **24**: 641–739. 1923) indicates that *Brachysporium* Sacc. is merely a repository for short-spored species, and *Napicladium* Thüm. is only a repository for tapered-spored species, and that both are only variations of *Helminthosporium* which are not constant and for which various intergradations can be demonstrated. In both Drechsler's and Gilman's (Manual of Soil Fungi, Ames, 1944) treatments the concepts out-

lined by Lindau are followed. That is, the conidiophores are geniculate and produce multiseptate dark spores acrogenously or, more usually and in mature specimens, acropleurogenously. The conidiospores are smooth.

Heterosporium was used first by Klotzsch in Herb. mycol. n. 67 and 69, 1832, for a phragmosporous dematiaceous fungus with rough spores. It was also used in this sense by M. C. Cooke (Grev. II. 122. 1877). While it is not so indicated in Lindau's description, the illustrations in the accompanying specific descriptions show acropleurogenous, geniculate conidiophores so that this fungus is essentially a repository for species of fungi like *Helminthosporium* with roughened spores. Lindau indicates that *Heterosporium* Klotzsch ex Cooke is mostly parasitic while *Helminthosporium* is mostly saprobic. This is not a usable delimitation since a large number of species of *Helminthosporium* are parasitic.

Dendryphiella was erected by Bubak & Ranojevic (N. Ranojevic, Dritter Beitrag zur Pilzflora Serbiens, Ann. Myc. **12**: 393–421. 1914) to accommodate species of phragmosporous dematiaceous fungi whose conidia are roughened and produced acropleurogenously on geniculate conidiophores. It was based on *Helminthosporium interseminatum* Berk. & Rav. Berkeley included the species in *Helminthosporium.* Probably he did not consider the roughness on the spores as sufficient for generic segregation. *Dendryphiella* is plainly a synonym of *Heterosporium.*

HELMINTHOSPORIUM INTERSEMINATUM Berk. & Rav. This species is occasionally found as a brown-black to purple-black fungus on dead herbaceous or woody stems. It is poorly represented in herbaria but specimens on *Sambucus* and *Phytolacca* have been examined and it has been reported on *Humulus* and *Anthriscus.* That it is widespread in eastern North America is indicated by the following locations from which material has been observed: Newfield, New Jersey (BPI, Cornell); Auburn, Lee Co., Alabama (Cornell); Tuskegee, Alabama (BPI); Lancaster, Fairfield Co., Ohio (BPI); Fayette Co., West Virginia (BPI); and near Iowa City, Iowa (St. Univ. of Iowa).

The felty area on the dead sticks may be sharply limited or have indefinite limits. It may be associated with other fungi but no relationship between these fungi and its life cycle is indicated. Upon

microscopic examination one finds an intricately interwoven mass of branched hyphae which stand erect from the substratum. No sterile hyphae were seen, nor are any described by other workers. The conidiophores may range from 100 to 500 μ long by 6 to 8 μ in diameter. They are simple or branched and when branched the branches become interwoven to form the observed felt. Near each septum may be produced 1–4 spores giving the conidiophores a nodulose or a geniculate appearance. Usually only one spore is produced but the scars of 2, 3, or 4 spore-production points are not infrequent. At the tip of the conidiophore spores also are produced so that the spores are produced acropleurogenously. The conidiophores are smooth to minutely roughened toward the tip.

The spores are usually four-celled although there may be four septa in some cases. They are roughened by fine verrucae. While the type description indicates that the spores are 20–22 μ long, in a collection by G. F. Atkinson at Auburn, Alabama, they are 21.8–25.2 × 4–5 μ, a measurement characteristic of other specimens examined.

Earlier writers indicate that *Helminthosporium vimineum* B. & C. var. γ and *Dendryphium nodulosum* Sacc. are synonyms.

HETEROSPORIUM SAMBUCI Earle. Material assigned to this species by Earle was collected by L. M. Underwood (NYBG) on Mar. 13, 1896, at Auburn, Lee Co., Alabama. Its characters agree well with those of *Helminthosporium interseminatum* and it was placed in synonymy with that species by Atkinson.

Dendryphiella interseminatum (Berk. & Rav.) Bub. & Ran. As indicated above this combination was made to accommodate this rough-spored species of *Helminthosporium* with geniculate conidiophores on which the spores are produced acropleurogenously. Since these conditions are all met by *Heterosporium,* this binomial should be placed in synonymy with the following.

HETEROSPORIUM INTERSEMINATUM (Berk. & Rav.) Atk.
Helminthosporium vimineum B. & C. var. γ
Helminthosporium interseminatum Berk. & Rav.
Dendryphium nodulosum Sacc.
Heterosporium sambuci Earle
Heterosporium interseminatum (Berk. & Rav.) Atk.
Dendryphiella interseminata (Berk. & Rav.) Bub. & Ran.

This combination was made in "Some fungi from Alabama," Bull. Cornell Univ. (Science) **3**(1): 1–50. June, 1897. Material on which this combination was based is housed at Cornell University and was collected in 1891 at Auburn, Lee Co., Alabama.

The writer wishes to acknowledge the assistance of Lee Bonar, Dept. of Botany, University of California, and L. E. Wehmeyer, Dept. of Botany, University of Michigan, in identifying the specimens described above; Donald P. Rogers, New York Botanical Garden, for checking the Latin diagnoses and reading the manuscript; the several people listed above for the loan of specimens; and C. G. Shaw, State College of Washington, for checking the manuscript.

BOTANY DEPT.,
STATE COLLEGE OF WASHINGTON,
PULLMAN, WASHINGTON

STUDIES ON ROCKY MOUNTAIN FUNGI—I [1]

W. G. Solheim [2]

This paper is the first in a proposed series in which the author plans to publish descriptions of new species and notes on other fungi of special interest. In 1934 the author started issuing a set of fungi entitled "Mycoflora Saximontanensis Exsiccata." Publications covering these issues have appeared in the "University of Wyoming Publications." In these several new species have been described. Through this new series wider circulation will be had for the descriptions of the new species.

In this paper nine species are described as new. All of these will be included in the fifth century of the exsiccata. The present distribution of the set is: Rocky Mountain Herbarium of the University of Wyoming, Farlow Herbarium of Harvard University, Arthur Herbarium of Purdue University, Herbarium of the New York Botanical Garden, Herbarium of the Bureau of Plant Industry, Herbarium of the Department of Plant Pathology of Cornell University, Herbaria of the Universities of California, Colorado, Illinois, Michigan, Tennessee, Wisconsin, Herbarium of Ohio State University, Cryptogamic Herbarium of the University of Toronto, Herbarium of Dr. F. Petrak, Herbarium of the Directorate of Plant Protection, Quarantines and Storage of India, and the author's private herbarium. A set was sent to the late Dr. H. Sydow but this was no doubt destroyed.

Anthostomella ratibidae sp. nov.

Maculis amphigenis, elongatis, usque ad 25×1 mm., nigris: peritheciis innatis, dispersis, globosis, brunneo-nigris, 175–300 μ, per epidermidem nigrifactam obtectis, epidermide in papillas elevata; ostiolo fere plano, 20–36 μ: ascis 8-sporis, cylindricis, 87–104 $\times$ 12.2–15.8 μ: sporidiis monostichis, oblongo-ellipsoideis, 12.2–16 $\times$ 7.5–8.7 μ, olivaceis, 1–2-guttulatis: paraphysatis.

[1] Contribution from the Department of Botany and the Rocky Mountain Herbarium of the University of Wyoming No. 215.

[2] The author gratefully acknowledges the assistance of a Grant-in-Aid from the Sigma Xi Research Fund.

Specimen typicum in foliis et caulibus *Ratibidae tagetis* (James) Barnhart (Compositae), Cienega Canyon Recreational Area, Sandia Mountains, Albuquerque, Bernalillo County, New Mexico, Amer. Bor., 24 Octobri, 1948, legerunt W. G. & Ragnhild Solheim, sub numero **2323**.

Spots amphigenous, elongate, up to 25 × 1 mm., black: perithecia innate, scattered, globose, brownish-black, 175–300 μ, covered by the blackened epidermis which is papillately raised over the perithecia; ostiole almost plane, 20–36 μ: asci 8-spored, cylindrical, 87–104 × 12.2–15.8 μ: spores uniseriate, oblong-elliptical, 12.2–16 × 7.5–8.7 μ, olivaceous, 1–2-guttulate: paraphysate.

On leaves and stems of *Ratibida tagetes* (James) Barnhart, Cienega Canyon Recreational Area, Sandia Mountains, Albuquerque, Bernalillo County, New Mexico, Oct. 24, 1948, W. G. & Ragnhild Solheim No. *2323* (*type*) (Myc. Sax. Exs. No. *428*).

Mature asci are rather rare in this specimen. The ascospores which are first hyaline and then olivaceous may possibly be much darker in more mature specimens.

Lophionema apoclastospora sp. nov.

Peritheciis dispersis vel subgregariis, leniter immersis, nigris, 500–1000 μ altis, ad basem depresso-sphaeroideis, 145–506 μ latis, superna parte prominente, fortiter in latera compressa, 115–318 μ latis, parte basali subinde circumdata mycelio brunneo et araneoso excrescente: mycelio regulari, atrobrunneo; hyphis 3–4 μ crassis, saepe fila parallelium vel intertextarum hypharum formante: paraphysibus numerosis, hyalinis, filiformibus, circa 1.2 μ crassis: ascis 8-sporis, anguste cylindrico-clavatis, ad basem aliquantulum attenuatis, aliquantulum flexuosis, 390–540 × 8.7–12.1 μ: sporidiis cylindraceis, utrimque rotundatis, multiseptatis, aliquando constrictis, olivaceo-brunneis, 300–470 × 2.3–3 μ, in segmenta derumpentibus; segmentis 7–31.3 μ longis, continuis vel 1–4-septatis.

Specimen typicum in caulibus emortuis et decorticatis *Salicis* sp. (Salicaceae), Libby Creek prope castra viae, Medicine Bow Mountains, Albany County, Wyoming, Amer. bor., 27 Junii, 1942, legit W. G. Solheim, sub numero **2025**.

Perithecia scattered or subgregarious, slightly immersed, black, 500–1000 μ high, basal portion depressed spherical, 145–506 μ wide, upper portion prominent, strongly compressed laterally, 115–318 μ wide, basal portion at times surrounded by brown, cobwebby, mycelial outgrowths: mycelium regular, dark brown; hyphae 3–4 μ diam., cells several times longer than broad, septa indistinct, frequently forming strands of parallel or interwoven hyphae: paraphyses numerous, hyaline, filiform, about 1.2 μ diam.: asci narrowly cylindrical-clavate, attenuated toward the base, somewhat flexu-

ous, 390–540 × 8.7–12.1 μ: spores cylindrical, ends rounded, multiseptate, constricted at fairly regular intervals, olive-brown, extending throughout most of the length of the ascus, 300–470 × 2.3–3 μ, breaking up at points of constriction into segments; segments 7–31.3 μ long, continuous or 1–4-septate.

On dead, decorticated stems of *Salix* sp., near road camp on Libby Creek, Medicine Bow Mountains, Albany County, Wyoming, June 27, 1942, W. G. Solheim No. *2025* (*type*) (Myc. Sax. Exs. No. *430*).

Only five species of *Lophionema* have previously been described. A comparison of these and the new species is given in table 1.

TABLE 1

COMPARISON OF THE SPECIES OF *Lophionema*

Species	Perithecia	Asci	Spores	Segments
vermisporum (Ell.) Sacc.	150–200	150–200× 12–15	75–88×3.5–5	
implexum Ell. & Ev.	about 1/3 mm.	150–160× 8–10	subequal to asci	
bambusae v. Höhn.	0.5–1 mm. wide, 500–700 μ high	to 300×10	300×1.8	6–10
chodati Lendner	150 high× 450 wide	90×12–15	80	6–7
cylindrosporum Kauffman	about 200	about 85× 17–20	60–65×4–5	
apoclastospora Solh.	500–1000 high, 145–506 wide at base, 115–318 wide at top	390–540× 8.7–12	300–470× 2.3–3	7–31

Phyllosticta alpinicola sp. nov.

Maculis indefinitis, superficie superna foliarum brunnescente vel nigrobrunnescente in partibus indefinitis vel toto folio decoloratis, superficie inferiore folii simili sed nigriore, ut videtur, propter copiam pycnidiarum et structurarum similium paratheciis: mycelio subhyalino vel flavo; hyphis tenuibus, 1–3 μ: pycnidiis hypophyllis, dispersis, numerosis, globosis, in lineamento circularibus vel in latera compressis vel irregularibus, pallidobrunneis, 66–132 μ; ostiolo plano vel leniter papillato, 24–45 μ: conidiis bacilliformibus, rectis vel leniter curvatis, hyalinis, 4–7 × 0.9–1.2 μ.

Specimen typicum in foliis vivis *Trifolii parryi* Gray (Leguminosae), latere viae infra Brooklyn Lake, Medicine Bow Mountains, Albany County,

Wyoming, Amer. bor., 16 Augusti, 1930, legit W. G. Solheim, sub numero 50.

Spots indefinite, the upper leaf surface becoming brown to blackish-brown in indefinite sectors or the whole leaflet frequently discolored, lower leaf surface similar but appearing blacker due to the abundance of pycnidia and perithecial-like structures: mycelium subhyaline to yellowish; hyphae fine, 1–3 μ: pycnidia hypophyllous, scattered, numerous, globose, in outline circular to laterally compressed to irregular, light brown, 66–132 μ; ostiole plane or slightly papillate, 24–45 μ: conidia bacilliform, straight or slightly curved, 4–7 × 0.9–1.2 μ.

On living leaves of *Trifolium parryi* Gray, roadside below Brooklyn Lake, Medicine Bow Mountains, Albany County, Wyoming, Aug. 16, 1930, W. G. Solheim No. *50* (*type*) (Myc. Sax. Exs. No. *454*).

Associated with this fungus are few to many, immature, blackish-brown, perithecial-like bodies.

This species differs from *P. bonansiana* Sacc. in having smaller conidia. Saccardo (Syll. Fung. **25**: 49) gives the dimensions of the conidia as 7 × 2.5 μ. *P. trifolii* Rich. (Syll. Fung. **10**: 128) has ovoid conidia 2–3 μ long. *P. medicaginis* (Fckl.) Sacc. has spores 5–10 × 1.5–2 μ as represented in a pure culture specimen made by Dr. Lee Bonar, University of California Herbarium No. *568035*. Grove (Brit. Stem- and Leaf-Fungi **2**: 140. 1937) has this species as a synonym of *Sporonema phacidioides* Desm. and gives the dimensions of the conidia as 5–7 × 1.5–2 μ. The measurements for *P. trifolii-minoris* Unam. (Bol. R. Soc. Espan. Hist. Nat. **29**: 120–121. 1929) are: pycnidia 75.5–83.5 × 66.5–73.5 μ, conidia 5–7 × 2.5–3.5 μ. *P. ignatiana* Unam. (Mem. R. Soc. Espan. Hist. Nat. **15**: 348. 1929) is described as having pycnidia 130 × 140 μ and conidia 6.5–7 × 3 μ.

Phyllosticta ragnhildae sp. nov.

Maculis amphigenis, subcircularibus, ellipticis vel elongatis, 2–14 × 2–5 mm., aliquando nervulis maioribus limitatis, atrobrunneis vel nigris, margine indefinita, folii textura cingente flavescente: mycelio hyalino; hyphis 2–3.5 μ: pycnidiis amphigenis, dispersis, globosis, aliquando in latera compressis, 87–146 × 76–111 μ, pallido-brunneis; ostiolo plano, 20–42 μ: conidiis bacilliformibus, rectis vel curvatis, hyalinis, 3.5–5.2 × 1 μ.

Specimen typicum in foliis vivis *Antennariae pulcherrimae* (Hook.) Greene (Compositae), Happy Jack Picnic Area, Laramie Mountains, Albany

County, Wyoming, Amer. bor., 6 Augusti, 1942, legerunt W. G. & Ragnhild Solheim, sub numero **2093**.

Spots amphigenous, subcircular, elliptical to elongate, 2–14 × 2–5 mm., at times limited by the larger veins, dark brown to black, border indefinite, surrounding leaf tissue becoming yellow: mycelium hyaline; hyphae 2–3.5 μ: pycnidia amphigenous, scattered, globose, at times laterally compressed, 87–146 × 76–111 μ, light brown; ostiole plane, 20–42 μ: conidia bacilliform, straight or curved, hyaline, 3.5–5.2 × 1 μ.

On living leaves of *Antennaria pulcherrima* (Hook.) Greene, Happy Jack Picnic Area, Laramie Mountains, Albany County, Wyoming, Aug. 6, 1942, W. G. & Ragnhild Solheim No. *2093* (*type*) (Myc. Sax. Exs. No. *462*).

P. antennariae Ell. & Ev. has conidia 7 × 3 μ. Associated with this specimen are immature fruiting bodies, probably young perithecia. It is possible that the new species is the spermagonial stage of some ascomycete.

Phyllosticta smilacinae sp. nov.

Maculis amphigenis, elongatis, in maximam partem nervulis maioribus limitatis, 1–5.5 cm. longis, 3–7 mm. latis, pallido-brunneis, brunneis vel brunneo-albis, aliquando partim chlorinis, margine in latera definita, in terminis definita vel indefinita, brunneis vel rufo-brunneis: mycelio subhyalino vel diluto flavido-chlorino; hyphis 1.2–3.5 μ: pycnidiis epiphyllis, subinde hypophyllis, numerosis, dispersis, globosis vel leniter in latera compressis, pallidis flavo-brunneis, 49–83 μ; ostiolo in brevem papillam erecto, 14–35 μ: conidiis cylindrico-bacilliformibus, hyalinis, 4.5–7 × 1–1.4 μ, utrimque rotundatis.

Specimen typicum in foliis flavidis *Smilacinae amplexicaulis* Nutt. (Liliaceae), Ouray Picnic Grounds, Ouray, Ouray County, Colorado, 12 Octobri, 1948, legerunt W. G. & Ragnhild Solheim, sub numero **2250**.

Spots amphigenous, elongated, mostly limited by the major veins, 1–5.5 cm. long, 3–7 mm. wide, light brown, brown, to brownish-white, at times partly green, border definite laterally, definite to indefinite terminally, brown to reddish-brown: mycelium subhyaline to dilute yellowish-green; hyphae 1.2–3.5 μ: pycnidia epiphyllous, occasionally also hypophyllous, numerous, scattered, globose or slightly compressed laterally, light yellow-brown, 49–83 μ; ostiole short papillate, 14–35 μ: conidia cylindrical-bacilliform, hyaline, 4.5–7 × 1–1.4 μ, ends rounded.

On yellowing leaves of *Smilacina amplexicaulis* Nutt., Ouray Picnic Grounds, Ouray, Ouray County, Colorado, Oct. 12, 1948,

W. G. & Ragnhild Solheim No. 2250 (type) (Myc. Sax. Exs. No. 464).

This species differs from *P. vagans* Pk. in the larger spores and the production of definite spots. In *P. vagans* the pycnidia are recorded as 75–90 μ and the spores 3 × 1 μ. *P. woronowii* Woronichin is described as having pycnidia 45–75 μ and conidia 3 × 1 μ. It is probably not distinct from *P. vagans.* The other species of *Phyllosticta* described on *Smilacina* and related genera have ovoid and wider conidia.

Phleospora muhlenbergiae Sprague & Solh. sp. nov.

Maculis coloris straminei, sine marginibus: pycnidiis dispersis vel subgregariis, innatio-erumpentibus, subcarbonaceis, subglobosis, elliptico-oblongis vel obtuso-lenticularibus, nigro-brunneis, 95–245 × 65–121 μ; poro irregulariter marginato, qui videtur velut erosus, elongato-elliptico, 45–170 × 38–104 μ: conidiis subcylindraceis vel anguste obclavatis, apice subacuto, basi vergente in rotundum sed postea obtusa, curvulis vel aliquando rectis, subhyalinis vel pallide chlorino-flavidis, 21–45 × 2.6–4 μ, 1–2-septatis.

Specimen typicum in foliis vivis *Muhlenbergiae arizonicae* Scribn. (Agrostideae), Oak Flats Picnic Grounds, Santa Catalina Mountains, prope Tucson, Arizona, Amer. bor., 12 Novembris, 1948, legerunt W. G. & Ragnhild Solheim, sub numero **2448**.

Spots straw colored, without borders: pycnidia scattered to subgregarious, innate-erumpent, subcarbonous, subglobose, elliptical-oblong to bluntly lenticular, blackish-brown, 95–245 × 65–121 μ; pore irregularly margined, appearing as if eroded away, elongate-elliptical, 45–170 × 38–104 μ: conidia subcylindrical to narrowly obclavate, apex tapering to a softly blunted point, base round-tapering, finally blunt, subhyaline to pale greenish-yellow, curved or at times straight, 21–45 × 2.6–4 μ, 1–2-septate.

On living leaf blades and sheaths of *Muhlenbergia arizonica* Scribn., Oak Flats Picnic Grounds, Santa Catalina Mountains, east of Tucson, Arizona, Nov. 12, 1948, W. G. & Ragnhild Solheim No. 2448 (*type*) (Myc. Sax. Exs. No. *478*).

The spores of this species are smaller than those of *P. idahoensis* Sprague and *P. graminivora* Sprague & Hardison.

Kabatia fragariae sp. nov.

Maculis nullis vel indefinitis vel definitis et irregularibus; superna superficie folii nigro-punctata, aliquando folii textura cingente flavida vel atrorufa; infera folii textura aliquando paucis et minutis et nigris punctis maculata; textura infra pycnidia epiphylla leniter discolorata vel albido-flavida: mycelio

hyalino; hyphis tenuibus, circa 0.8–1.7 μ: pycnidiis plerumque epiphyllis, subinde hypophyllis, numerosis, dispersis vel gregariis, dimidiatis, disparis coloris atro-brunnei et cinereo-brunnei, marginibus flavis et distincte radiatis, in lineamentis circularibus, subellipticis vel aliquantulum irregularibus, 70–376 × 70–290 μ; poro simplici elongato vel irregulariter furcato et recurvo, cum utraque superficie scutelli exhibente breves, atrobrunneas cellulas papillatas: conidiophoris clavatis, hyalinis, circa 10 × 2.3 μ: conidiis falcatis, apud apicem apiculatis, ad basem attenuatis, hyalinis, 18–28 × 4.5–6.5 μ, 1-septatis.

Specimen typicum in foliis vivis *Fragariae ovalis* (Lehm.) Rydb. (Rosaceae), Happy Jack Picnic Area, Laramie Mountains, Albany County, Wyoming, Amer. bor., 8 Augusti, 1942, legerunt W. G. & Ragnhild Solheim, sub numero **2114**.

Spots none or indefinite or definite and irregular; upper surface of the leaf black dotted or peppered with the pycnidia, at times with the surrounding leaf tissue yellowish to dark red; lower leaf surface at times with a few, minute, black spots, leaf tissue below the epiphyllous pycnidia only slightly discolored or at times becoming whitish-yellow: mycelium hyaline; hyphae fine, about 0.8–1.7 μ in diameter: pycnidia mostly epiphyllous, occasionally hypophyllous and then below those occurring on the upper surface, numerous, scattered or so closely aggregated as to appear coalescent, dimidiate, mottled dark brown and grayish-brown, edges yellow and distinctly radiate, outline circular to subelliptical to somewhat irregular, 70–376 × 70–290 μ, opening by a simple, elongate slit or by irregular, branched slits, the free ends curling back, both surfaces of the scutellum with short, dark brown, papillate cells: conidiophores clavate, hyaline, about 10 × 2.3 μ: conidia falcate, apiculate at apex, tapering toward base, 18–28 × 4.5–6.5 μ, hyaline, 1-septate.

On living leaves of *Fragaria ovalis* (Lehm.) Rydb., Happy Jack Picnic Area, Laramie Mountains, Albany County, Wyoming, Aug. 8, 1942, W. G. & Ragnhild Solheim No. 2114 (*type*) (Myc. Sax. Exs. No. *482*).

A comparison of the species of *Kabatia* is given in table 2.

TABLE 2

COMPARISON OF THE SPECIES OF *Kabatia*

Species	Pycnidia	Spores
lonicerae (Harkn.) Höhn. = ***latemarensis*** Bub.	110–180	24–46×6–9
mirabilis Bub.	100–180	33–55×7–11
fragariae Solh.	70–376×70–290	18–28×4.5–6.5

Cylindrosporium corni sp. nov.

Maculis amphigenis, supra conspicuis magis quam infra, subcircularibus angulosis vel irregularibus, minutis, 0.5–2 mm., fumosocinereis, margine angusta, elevata, atra, cingulata cingulis rufopurpureis: mycelio intercellulari, hyalino vel subhyalino; hyphis tenuibus, 0.8–2.5 μ: acervulis epiphyllis, dispersis, subcircularibus, 42–80 μ: conidiophoris hyalinis vel subhyalinis, 6–14 $\times$ 2.5–3.5 μ: conidiis filiformibus, ad apicem attenuatis, flexuosis, hyalinis, 45–87 $\times$ 1.5–2 μ, 1–5-septatis.

Specimen typicum in foliis vivis *Corni stoloniferae* Michx. (Cornaceae), Six Mile Gap, Platte River, Medicine Bow Mountains, Carbon County, Wyoming, Amer. bor., 7 Septembri, 1948, legit W. G. Solheim, sub numero **2224**.

Spots amphigenous, more conspicuous above than below, subcircular, angular to irregular, minute, 0.5–2 mm., smoky-gray, with a narrow, raised, dark border, surrounded by a reddish-purple zone: mycelium intercellular, hyaline to subhyaline; hyphae fine, 0.8–2.5 μ: acervuli epiphyllous, scattered, subcircular, 42–80 μ: conidiophores hyaline to subhyaline, 6–14 $\times$ 2.5–3.5 μ: conidia filiform, tapering upward, flexuous, hyaline, 45–87 $\times$ 1.5–2 μ, 1–5-septate.

On living leaves of *Cornus stolonifera* Michx., Six Mile Gap, Platte River, Medicine Bow Mountains, Carbon County, Wyoming, Sept. 7, 1948, W. G. Solheim No. 2224 (*type*) (Myc. Sax. Exs. No. *488*).

The spots are frequently localized in larger discolored areas of the leaf. In view of the fact that many of the spots are independent of these discolored areas it is possible that these discolored areas are not caused by this fungus.

Cylindrosporium saximontanense sp. nov.

Maculis amphigenis, subcircularibus, irregularibus vel angulosis, nervis limitatis, 2–7 mm. longis, brunneis, supra cinerescentibus: marginatis per nervulos supra nigrescentes, infra flavescentes: mycelio intercellulari, subhyalino; hyphis 1.3–3.5 μ: acervulis innatis, nigro-punctatis, epiphyllis, subcircularibus vel leniter ellipticis, 94–160 $\times$ 80–115 μ: conidiophoris 8–12 $\times$ 3–3.5 μ: conidiis cylindricis vel cylindrico-fusiformibus, rectis vel leniter curvis, subhyalinis vel pallide chlorino-flavis, 28–58 $\times$ 3.5–5.2 μ, non septatis.

Specimen typicum in foliis *Populi angustifoliae* James (Salicaceae), Ouray Picnic Grounds, Ouray, Ouray County, Colorado, Amer. bor., 12 Octobri, 1948, legerunt W. G. & Ragnhild Solheim, sub numero **2258**.

Spots amphigenous, subcircular, irregular to angular, vein-limited, 2–7 mm. long, brown, becoming grayish above, bordered by the veins which become blackish above and yellow below: mycelium intercellular, subhyaline; hyphae 1.3–3.5 μ: acervuli

innate, black punctate under a hand lens, epiphyllous, subcircular or slightly elliptical, $94–160 \times 80–115\ \mu$: conidiophores $8–12 \times 3–3.5\ \mu$: conidia cylindrical to cylindrical-fusiform, straight or slightly curved, subhyaline to dilute greenish-yellow, $28–58 \times 3.5–5.2\ \mu$, continuous.

On leaves of *Populus angustifolia* James, Ouray Picnic Grounds, Ouray, Ouray County, Colorado, Oct. 12, 1948, W. G. & Ragnhild Solheim No. 2258 (*type*) (Myc. Sax. Exs. No. *490*).

This differs from *C. oculatum* Ell. & Ev. on this same host in having larger, more irregular spots and epiphyllous acervuli and in having broader, nonseptate conidia.

ACKNOWLEDGMENTS

Most of the work on which this paper is based has been done in the Herbarium of the University of California at Berkeley. The author expresses his sincere appreciation to Dr. Lee Bonar for providing facilities for work and for his many courtesies. The author is especially indebted to Dr. William H. Alexander, Professor Emeritus of Latin of the University of California, for checking and correcting the Latin diagnoses and for aid in compounding the specific name "*apoclastospora*."

MINERAL OIL AND PRESERVATION OF FUNGOUS CULTURES

Mary E. Stebbins and William J. Robbins [1]

Buell and Weston [2] reported the use of heavy mineral oil for the preservation of fungous cultures. The fungi covered by their report included few Basidiomycetes. Since we had many of this group in our collection [3] to which the oil method has been applied, it seems desirable to supplement their results by a report on ours. For a review of earlier literature and details of the method, the reader is referred to the article by Buell and Weston.

Beginning March 4, 1947, cultures of 1959 isolations of fungi [4] were transferred to 2 per cent malt agar slants. The tubes were incubated at 25° C. until growth had started (2 days to 1 week) and were then put at 15° C. until the fungi had grown over the surface of the slants (about 2 weeks from the time of inoculation). The slants were not left at 25° C. for 2 weeks because the agar became too dry. The slants were then covered with sterile mineral oil. The oil was Parke-Davis heavy mineral oil, and enough was used in each tube to come about 1 cm. above the top of the agar slant. After they were oiled, all tubes were placed in an upright position at 15° C.

Species of the following genera were treated with mineral oil:

[1] This investigation was supported in part by the Howard Bayne Research Fund of The New York Botanical Garden.

[2] Buell, Caroline B., and William H. Weston. Application of the mineral oil conservation method to maintaining collections of fungous cultures. Am. Jour. Bot. **34**: 555–561. 1947.

[3] We are indebted to a number of colleagues for the majority of our cultures. It is not possible to mention all of them but the following were especially generous: Dow V. Baxter, Ross W. Davidson, H. M. Fitzpatrick, Carl Hartley, Roger Heim, H. S. Jackson, Anna E. Jenkins, Jose Emilio Santos Pinto-Lopes, Mildred K. Nobles, Caroline T. Rumbold, H. H. Whetzel, W. Lawrence White and W. H. Wilkins.

[4] These included 853 identified and 100 unidentified species. The balance (1006) were duplicate isolations.

	Number of species
ACTINOMYCETES	
Actinomyces	2
	—
PHYCOMYCETES	
Absidia	2
Conidiobolus	1
Mucor	2
Phycomyces	2
Phytophthora	1
Pythiomorpha	1
Pythium	2
Rhizopus	3
	14
ASCOMYCETES	
Apioporthe	1
Ashbya	1
Botryotinia	5
Ceratostomella	19
Chaetomium	5
Ciboria	5
Ciborinia	1
Claviceps	1
Cryptodiaporthe	2
Elsinoë	9
Endoconidiophora	3
Endothia	1
Gibberella	2
Grosmannia	1
Lambertella	5
Massaria	1
Massariovalsa	1
Melanconis	1
Monascus	1
Morchella	1
Neurospora	3
Ophiobolus	1
Ophiostoma	1
Pyrenochaeta	1
Rutstroemia	1
Sclerotinia	9
Streptotinia	1
Stromatinia	2
Teichospora	1
Thielavia	2
Xylaria	1
	89
BASIDIOMYCETES	
Agaricus	1
Agrocybe	2
Aleurodiscus	7
Alnicola	2
Armillaria	1
Auricularia	1
Calocera	1
Calodon	1
Calvatia	2
Ceracea	1
Claudopus	1
Clavaria	5
Clitocybe	8
Collybia	7
Coniophora	6
Conocybe	2
Coprinus	20
Coriolus	1
Corticium	35
Crepidotus	3
Crucibulum	1
Cyathus	1
Cyphella	1
Cytidia	1
Dacryomyces	3
Daedalea	9
Deconica	2
Drosophila	17
Echinodontium	1
Eichleriella	1
Exidia	2
Favolus	2
Femsjonia	1
Fistulina	1
Flammula	6
Fomes	42
Fomitiporia	3
Galera	1
Galerina	1
Ganoderma	3
Gloeocystidium	1
Gloeotulasnella	1
Grandinia	2
Helicogloea	2
Hericium	2
Hirneola	1
Hydnum	10
Hymenochaete	5
Hypholoma	2
Hypochnus	2
Irpex	2
Lentinus	6
Lenzites	10
Lepiota	1
Leptoporus	1
Lycoperdon	2
Marasmius	6
Melanoleuca	1
Merulius	6
Mucidula	2
Mucronella	1
Mycena	3
Mycoacia	1

	Number of species		Number of species
BASIDIOMYCETES (Cont'd.)		Botrytis	4
Naucoria	1	Brachysporium	1
Nyctalis	1	Cadophora	2
Odontia	7	Cephalosporium	1
Omphalia	3	Cephalothecium	1
Oxydontia	2	Cercosporidium	1
Panaeolina	1	Chaetomella	1
Panaeolus	5	Chalaropsis	1
Panellus	1	Cladosporium	2
Panus	5	Coccosporium	1
Paxillus	1	Curvularia	4
Pellicularia	3	Dendryphium	1
Peniophora	30	Epidermophyton	2
Phaeolus	1	Fusarium	1
Phallus (Ithyphallus)	1	Gliocladium	4
Phellinus	2	Gliomastix	1
Phlebia	4	Helicoma	1
Pholiota	12	Helminthosporium	1
Pleurotus	9	Heterosporium	1
Pluteus	1	Hormiactella	1
Polyporus	104	Humicola	1
Polystictus	2	Macrosporium	1
Poria	67	Memnoniella	1
Psalliota	1	Metarrhizium	3
Pseudocoprinus	2	Microsporum	4
Ptychogaster	2	Monotospora	1
Radulum	2	Myrothecium	3
Schizophyllum	2	Myxosporium	1
Sebacina	3	Myxotrichella	1
Solenia	1	Nigrospora	1
Sparassis	1	Penicillium	9
Sphaerobolus	1	Pestalotia	4
Spongipellis	1	Phialophora	2
Steccherinum	2	Phoma	1
Stereum	24	Pullularia	1
Stropharia	2	Rhizoctonia	2
Trametes	24	Sclerotium	2
Trechispora	2	Scopulariopsis	2
Tremella	1	Sphaceloma	10
Tricholoma	2	Sphaeropsis	1
Trogia	1	Sporotrichum	2
Tulasnella	2	Stachybotrys	2
Typhula	1	Stemphyllium	3
Ungulina	2	Stysanus	1
Vararia	4	Synsporium	1
Volvaria	1	Tetracoccosporium	1
Xanthochrous	3	Torula	1
		Trichophyton	8
	626	Trichosporium	1
		Tritirachium	2
FUNGI IMPERFECTI		Verticicladium	1
Achorion	1	Verticillium	1
Acladium	1	Volutella	1
Acremonium	1	Xenosporium	1
Alternaria	1	Zygodesmus	1
Aspergillus	7		
Botryodiplodia	1		122

All the cultures were examined at intervals and the following observations were made:

Some of the fungi grew better under oil. Among these were species of *Corticium, Epidermophyton, Ashbya, Massaria, Melanconis, Nyctalis, Elsinoë* and *Sphaceloma*. For example, species of *Melanconis, Elsinoë* and *Sphaceloma,* which formed small colonies with limited growth on 2 per cent malt agar, covered the entire slant under oil.

Five types of growth under oil were noted. The numbers refer to the number of isolations in each type.

(1) The mycelium grew appressed to the agar slant. None developed in the oil. (437)

(2) The mycelium grew over the agar slant as in (1) but the mycelial surface was fuzzy. (524)

(3) The mycelium filled the oil but stopped at the surface of the oil or a short distance below it. (145)

(4) A band of mycelium ranging in thickness from less than 1 mm. to 10 mm. formed across the tube directly beneath the surface of the oil and above the top of the agar slant. The oil below this band was free of mycelium. (383)

(5) A narrow band of mycelium (2 mm. or less in thickness) formed at the top of the slant and hung down over the slant with varying amounts of oil free of mycelium above and below the band. (470)

In general, the species of each genus tended to have the same type of growth. However, there were exceptions, and in some instances isolations of the same species differed in type of growth.

The mycelium of a substantial number (153) of the cultures eventually grew up out of the oil. In such cultures evidence of partial drying of the agar slant was observed. The oiled cultures were therefore examined at intervals of six months and additional mineral oil added to those in which the mycelium appeared above the oil.

Pigments from some of the fungi dissolved in the oil. The colors ranged from tan and light yellow to a medium reddish purple, deep red or deep yellow. *Phlebia strigosozonata* and

species of *Elsinoë* and *Sphaceloma* developed pink, orange and red pigments, yellows were observed for species of *Aspergillus, Corticium, Drosophila, Hydnum, Oxydontia, Poria, Tetracoccosporium* and several others (20 genera in all). The reddish purple color was found only with cultures of *Helminthosporium.*

Some of the fungi did not develop their normal color under oil. *Corticium coeruleum* did not form its dark blue pigment, nor did species of *Fusarium* or *Gibberella* become red. *Penicillia* were white, tan or faint olive-green instead of green or blue-green.

Beginning January 21, 1948, transfers were made from the oiled cultures. Bits of mycelium were drained as free from oil as possible by patting them against the inside of the oiled tube and were transferred to fresh 2 per cent malt agar slants. The slants were incubated at 25° C. All the fungi were viable except *Pythium butleri, P. helicoides, Peniophora sambuci,* two isolations of *Sebacina cinerea* and two unidentified species of *Sebacina.* The five latter fungi grew poorly and slowly on malt agar before oiling.

In general, it was our impression that the subcultures from the oiled cultures grew more vigorously than transfers from unoiled cultures.

The cultures oiled in 1947 were again tested for viability in January 1949 after two years under oil. Transfers of *Ashbya gossypii* and *Phallus* (*Ithyphallus*) sp. failed to grow; both had survived one year under oil. All others grew.

Additional fungi were treated with mineral oil in 1948. Of these, only five genera—*Acanthocystis, Amanita, Armillariella, Eremothecium* and *Rhodopaxillus*—were not included in the original set. All were tested after one year under oil and found to be viable.

DEPARTMENT OF BOTANY, COLUMBIA UNIVERSITY
AND NEW YORK BOTANICAL GARDEN

NEW CELLULOSE DESTROYING FUNGI ISOLATED FROM MILITARY MATERIAL AND EQUIPMENT

L. M. AMES *

(WITH 42 FIGURES)

Cellulose destroying fungi are valued for their part in the process of reducing plant remains to humus for the enrichment of the soil. The magnitude of this valuable decomposition process is scarcely considered by most people because it is so commonplace and proceeds naturally and continuously. However, these organisms do not distinguish between waste cellulosic materials and the raw or fabricated cellulosic goods of value to human needs. In this latter respect, the destruction of vast quantities of goods by fungi during the recent war focused the attention of military departments on the need of finding means of preserving and lengthening the life and dependability of military equipment. This entailed identifying the organisms concerned as well as prescribing and testing preservative materials. The efforts to this end have been shared by the military departments with civilian government agencies, commercial research establishments, and college laboratories. Although much progress has been made to prolong the life and dependability of cellulosic materials, only a good start has been made to solve the many encountered problems. Many people in industry and government are synthesizing new chemical compounds designed to treat various goods to prevent mildewing. At the same time, many independent and cooperative screening tests are in progress to evaluate old and new fungicides; the more promising are put through many additional exacting evaluation tests. Paralleling these researches, the fungi responsible for mildewing have received considerable attention.

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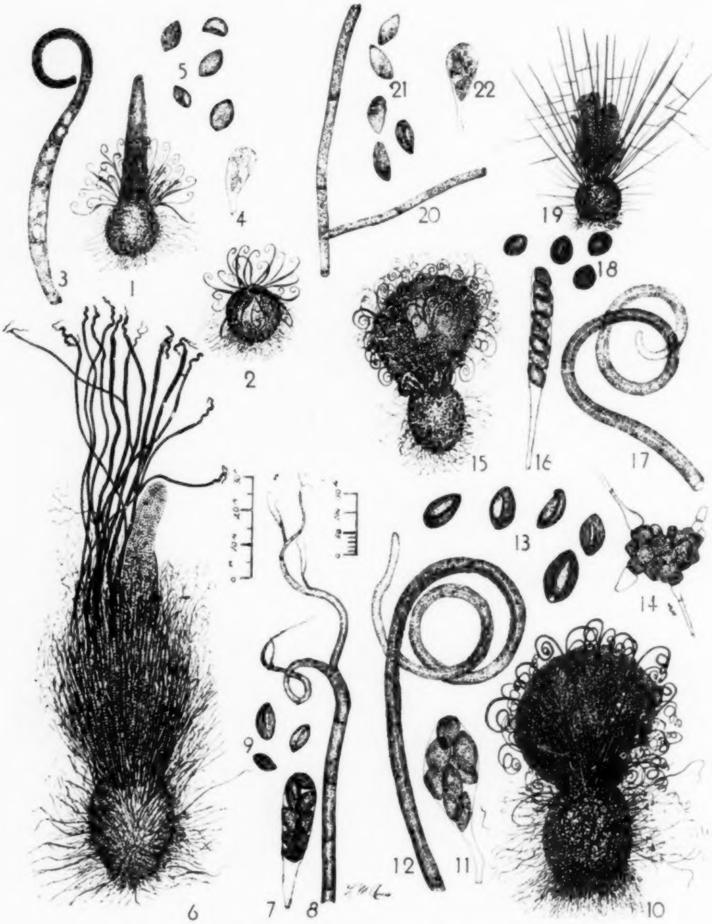
Many and various kinds of fungi have been isolated from deteriorating equipment at home and in foreign areas; these fungi have been studied both as to their identity and their physical char-



FIGS. 1–22. New species of *Chaetomium.*

acteristics. In the course of isolating and studying fungi from rotting equipment, new organisms, from time to time, have been discovered following which their morphology and growth charac-

teristics were observed. This paper is concerned primarily with nine hitherto undescribed species of mildew-producing fungi belonging to the genus *Chaetomium*. These are illustrated and described below.

Chaetomium turgidopilosum sp. nov. Figs. 1–5.

Peritheciis pullis, ostiolatis, globosis vel ovatis, 120–140 × 115–135 μ, cirrhis conspicuis provisis et rhizoideis tenellis ad substratum affixis. Pilis lateralibus numerosis, distincte septatis, tenuibus. Pilis terminalibus robustis, rigidis, distincte septatis, basi dilute brunneis supra pallidioribus, medio plerumque plus minusve inflatis, 5–8 μ latis, in apicibus frequenter recurvatis angustatis. Ascis clavatis, octosporis, 20–22 × 9.5–11.5 μ, parte sporifera 15 μ. Ascosporis maturis brunneis, limoniformibus, utrinque leniter apiculatis, 8–11 × 4–7 μ.

Perithecia soiled gray in color, ostiolate, globose to ovate, 120–140 × 115–135 μ, provided with conspicuous cirrhi, attached to the substratum with delicate rhizoids. Lateral hairs numerous, distinctly septate, tapering. Terminal hairs large, rigid, distinctly septate, light brown at the base, lighter in the usually inflated middle section, narrower and darker at the recurved apex. Asci clavate, eight-spored, 20–22 × 9.5–11.5 μ, spore part 15 μ. Mature ascospores are brown, lemon-shaped somewhat apiculated at both ends, 8–11 × 4.7 μ.

Type—isolated from the top of a storage tent. Culture was made by Dr. G. W. Martin and sent to the writer under the designation J-730 APO 929 (A-lff).

This species is easily recognized by the distinctively inflated terminal hairs which are reflexed at their tips.

Chaetomium cristatum sp. nov. Figs. 6–9.

Peritheciis griseis, magnitudinis mediae, ovatis in subglobosis gradientibus, ostiolatis, 250–300 × 175–225 μ, cum rhizoideis brunneis dilutis paratis. Pilis lateralibus copiosis, gracilibus, septatis, apicibus acuminatis. Pilis terminalibus typorum duorum: (a) aliis numerosis septatis, simpliciter vel compositer ramosis, basi 3–4 μ diametro, apicibus subtiliter divisis, peritheciis bysso similibus sedentibus; (b) aliis parvis, longis, atris, basi 6–8 μ diametro, pilos byssinos excedentibus, interdum in madore anastomosantibus quandoque apice ramis parvulis. Ascis clavatis, octosporis, 45 × 12 μ, parte sporifera 28 μ. Ascosporis maturis ovatis, umbonatis vel subapiculatis, olivaceo-brunneis, 8–12 × 4.5–6 μ.

Perithecia gray, of medium size, ovate to subglobose, ostiolate, 250–300 × 175–225 μ, attached to the substrate with light brown

rhizoids. Lateral hairs are numerous, slender, septate and gradually decreasing in diameter to the apex. The terminal hairs are of two types: (a) the first are numerous, septate, branched and rebranched, at the base 3–4 μ in diameter and decreasing to thin tips giving the plant a fuzzy appearance; (b) the second are few in number, long and black, at the base 6–8 μ in diameter, extending through and beyond the first type, are occasionally seen anastomosed near the tips which are sometimes abruptly frayed with little branches. Asci clavate, eight-spored, 45 × 12 μ, spore part 28 μ. Ascospores, when mature, are umbonate to subapiculate, olive-brown, 8–12 × 4.5–6 μ.

Type—isolated from paper carton under test in the Tropical Testing Chamber, Fort Belvoir, Virginia.

Chaetomium gangligerum sp. nov. Figs. 10–14.

Peritheciis fulvis, ostiolatis, magnitudinis mediae, ovatis in subglobosis gradientibus, 230–260 × 190–210 μ, sine cirrho, rhizoideis numerosis ad substratum affixis. Pilis lateralibus copiosis, gracilibus, septatis, apicibus acuminatis. Pilis terminalibus numerosis, distincte vel obscure septatis, tenuibus barbellatis, basi rectis vel arcuatis, fulvis, diametro 3.5–4.25 μ, apice spiraliter recurvatis. Ascis clavatis, octosporis, 50 × 18 μ, parte sporifera 36 μ. Ascosporis maturis brunneis, ovatis vel globoso-ovatis, umbonatis vel subapiculatis 12–18 × 7–11 μ. In media agar-agar cum liquore tuberis *Solani tuberosi*, et farina *Zeae Maydis*, nodulorum hypogaeorum fuscorum varietatem forma et magnitudine differentibus, copiosam producens.

Perithecia tawny yellow, ostiolate, moderately large, ovate to subglobose, 230–260 × 190–210 μ, without cirrhi, attached to the substratum with numerous rhizoids. Lateral hairs are numerous, slender, septate and gradually decreasing in diameter to the apex. Terminal hairs numerous, distinctly or obscurely septate, coated with many little barbules, straight or curved from the base, tawny yellow in color, 3.5–4.25 μ in diameter, spirally recurved at the apex. Asci clavate, eight-spored, 50 × 18 μ, spore part 36 μ. Mature ascospores brown, ovate to globose-ovate, umbonate to subapiculate, 12–18 × 7–11 μ. In agar-agar media enriched with potato and corn meal broth, dark colored bulbils are formed in a variety of shapes and in large numbers.

Type—isolated from wood samples which were under test in the Tropical Testing Chamber, Fort Belvoir, Virginia.

This species is easily distinguished in culture because of the dark-celled bulbils it produces in the agar.

Chaetomium velutinum sp. nov. Figs. 15–18.

Peritheciis griseis, parvis, ovatis in subglobosis gradientibus, ostiolatis, 150–180 × 120–140 μ, interdum cum cirrho, rhizoideis numerosis, vix ad substratum affixis. Pilis lateralibus numerosis, gracilibus. Pilis terminalibus numerosis, septatis, gracilibus, barbellatis, diametro 4–5 μ, apice cum 1–3 convolutis. Ascis longis, cylindricis, octosporis, 65 × 7 μ, parte sporifera 38–42 μ. Ascosporis maturis olivaceo-brunneis dilutis, limoniformibus, umbonatis vel subapiculatis, 6.75–8.5 × 4–6 μ.

Perithecia gray, small, ovate to subglobose, ostiolate, 150–180 × 120–140 μ, occasionally producing cirrhi, lightly affixed to the substratum with numerous rhizoids. Lateral hairs numerous, slender. Terminal hairs numerous, septate, graceful, 4–5 μ in diameter, covered with little spines, and at the apex coiled in 1–3 convolutions. Asci long, cylindrical, eight-spored, 65 × 7 μ, spore part 38–42 μ. Mature ascospores dilute olive-brown, lemon-shaped, umbonate to subapiculate, 6.75–8.5 × 4–6 μ.

Type—isolated from a Japanese tent. Culture was made by Dr. G. W. Martin and sent to the writer under the designation J-359-APO 565 (J-lm).

This small, silver-gray species is easily distinguished by its cylindrical asci in which the spores are monostichous.

Chaetomium atrobrunneum sp. nov. Figs. 19–22.

Peritheciis fuscis, parvis, ostiolatis, globosis vel subglobosis, 80–120 × 80–110 μ, vel cirrhis vel sporis laxe acervatim in pilis terminalibus adhaerentibus, ad substratum rhizoideis stramineis affixis. Pilis lateralibus numerosis, tenuibus, distincte septatis, apice gradatim attenuatis. Pilis terminalibus longis, gracilibus, basi 3.75–4.75 μ diametro, saepe ramosis divaricatis, distincte septatis, apice gradatim attenuatis. Ascis clavatis, octosporis 30 × 10 μ, parte sporifera 18 μ. Ascosporis maturis pallidis olivaceo-brunneis, longis et angustis, paullo fusiformibus, utrinque rotundatis vel subacutis, 10–12 × 5.5–7.5 μ.

Perithecia dark brown, small, ostiolate, globose to subglobose, 80–120 × 80–110 μ, with cirrhi or with masses of spores loosely held in the terminal hairs, affixed to the substratum with straw-colored rhizoids. Lateral hairs numerous, slender, distinctly septate, gradually narrowing in diameter to the tips. Terminal hairs long, graceful, at the base 3.75–4.75 μ in diameter, often branched with wide angles to the main axis, distinctly septate, narrowing in diameter to a relatively sharp tip. Asci clavate, eight-spored, 30 × 10 μ, spore part 18 μ. Mature ascospores dilute olive-brown, long

and narrow, somewhat fusiform, rounded to subacute on the ends, 10–12 × 5.5–7.5 μ.

Type—isolated from a molded mattress cover from Guadalcanal. Culture was made by Dr. G. W. Martin and sent to the writer under the designation J-1041-(3-J3).

This species is readily distinguished by the rich brown terminal hairs which are branched with wide angles.

Chaetomium seminudum sp. nov. Figs. 23–29.

Peritheciis parvis, nigris, vasiformis, 150 × 70 μ (100–165 × 65–85 μ), ostiolatis, cum cirrhis longis, ad substratum rhizoideis tenellis affixis. Pilis lateralibus et terminalibus uniformibus, paucis, septatis, basi 3.5–4 μ diametro, apice gradatim attenuatis. Ascis clavatis, octosporis, maturitatem ante dissolutis. Ascosporis maturis olivaceo-brunneis dilutis, globoso-ovatis, extremo altero rotundatis, extremo alio subacutis, 13.5 × 11 μ (9–14 × 7–8 μ), In media agar-agar cum liquore tuberis, *Solani tuberosi,* et farina, *Zeae Maydis,* chlamydosporas copiosas producens.

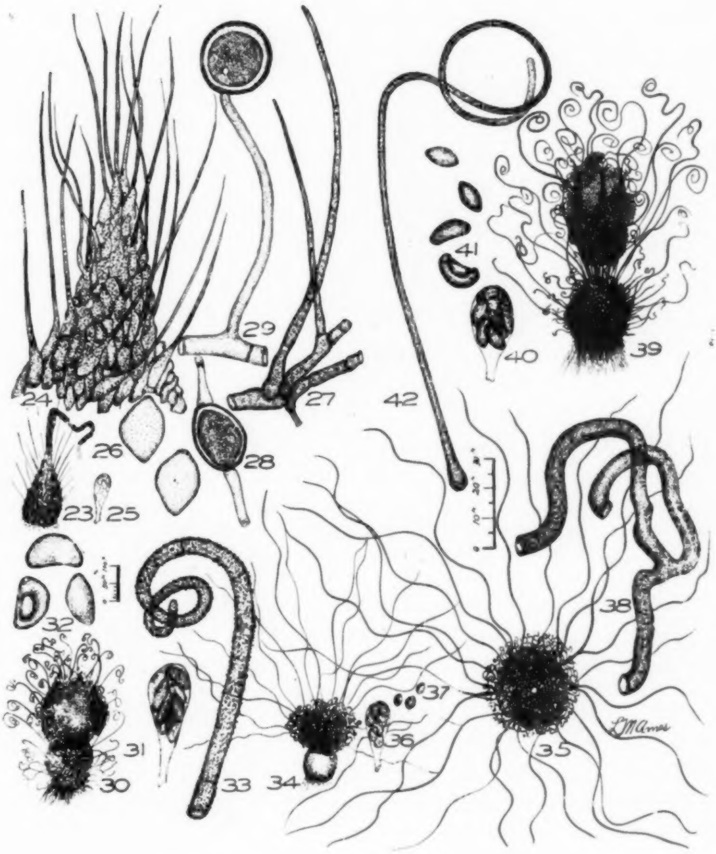
Perithecia small and black, vase-shaped, 150 × 70 μ (100–165 × 60–85 μ), ostiolate, with long cirrhi, attached to the substratum with translucent mycelium-like rhizoids. Lateral hairs and terminal hairs are alike, few in number, septate, at the base 3.5–4 μ in diameter, narrowing to a sharp tip. Asci clavate, eight-spored, liquefying before the spores mature. Mature spores light olive-brown, globose-ovate, the ends rotund to subacute in shape, 13.5 × 11 μ (9–14 × 7–8 μ). In agar-agar media enriched with potato and corn meal extract, myriads of chlamydospore-like bodies 10–15 μ in diameter are produced. Most of these bodies are borne on the ends of short slender stalks 30–50 μ in length by 2 μ; some are of intercalary origin (FIGS. 28 and 29). Scattered on the agar surface, very often, are hair-like structures which resemble the ornamental perithecial hairs (FIG. 27).

This interesting species was sent to the writer by Dr. J. C. Gilman, Iowa State College, Ames, Iowa. The plant is easily distinguished from all other described species of *Chaetomium* by its small seminude, vase-shaped perithecium and, in culture, by the copious formation of the chlamydospore-like bodies within the substratum.

Chaetomium cupreum sp. nov. Figs. 30–33.

Peritheciis parvis, ostiolatis, globosis vel ovatis, 110–120 × 120–130 μ, cirrhis conspicuis, rhizoideis tenellis ad substratum affixis. Pilis lateralibus

numerosis, gracilibus, distincte septatis, basi 3–3.5 μ diametro, apice 1–2 convolutis. Pilis terminalibus rigidis, distincte septatis, basi 4.5–6 μ diametro, apice 1–3 convolutis. Pilis lateralibus et terminalibus granulis cuprineis vestitis. Ascis clavatis, octosporis, 38 × 13 μ, parte sporifera 27 μ. Ascosporis maturis, globoso-ovatis, subapiculatis, 10 × 5.5 μ (8.5–11.5 × 5–5.5 μ).



FIGS. 23–42. New species of *Chaetomium*.

Perithecia bright copper colored, small, ostiolate, globose to ovate, 110–120 × 120–130 μ, with conspicuous cirrhi; attached to the substratum with undifferentiated rhizoids. Lateral hairs numerous, slender, distinctly septate, 3–3.5 μ in diameter at the base, and at the apex with 1–2 convolutions. The terminal hairs are

rigid, distinctly septate, 4.5–6 μ in diameter at the base with 1–3 covolutions at the apex. Lateral and terminal hairs are covered with small grains which are copper colored. Asci clavate, eight-spored, 38 × 13 μ, spore part 27 μ. Mature ascospores globose-ovate, subapiculate, 10 × 5.5 μ (8.5–11.5 × 5–5.5 μ).

This bright colored species was first sent to the writer by Dr. Paul Marsh, U. S. Department of Agriculture, Beltsville, Md., who obtained it from deteriorating material collected in Panama Canal Zone. A second collection was sent to the writer by Dr. G. W. Martin who isolated it from material shipped from Guadalcanal. This species is distinguished from other Chaetomia by its bright copper colored hairs. The pigment granules dissolve in alcohol, ether, cellosolve, and xylol, but not in water.

Chaetomium causiaeformis sp. nov. Figs. 34–38.

Peritheciis parvis, delicatulis, translucidis, ostiolatis, globosis vel subglobosis, 80–100 × 80–90 μ, sine cirrho, rhizoideis numerosis, vix ad substratum affixis. Pilis lateralibus paucis, gracilibus, translucidis, distincte septatis, tennibus, basi 1.25–2 μ diametro. Pilis terminalibus typorum duorum: (a) aliis brevibus numerosis circa ostiolis, septatis, compositer ramosis, basi 3–4 μ diametro, causia similibus. (b) aliis longis, undulatis, 4.25–5 μ diametro, tenuibus barbellatis, apicibus acuminatis, usque ad 1800 μ longis. Ascis clavatis, octosporis, 23 × 8 μ, parte sporifera 18 μ. Ascosporis maturis brunneis dilutis, ovatis vel subglobosis, 5 × 4 μ (4.75–5.25 × 3.0–4.5 μ).

Perithecia small, delicate, translucent, ostiolate, globose to subglobose, 80–100 × 80–90 μ, without cirrhi, rhizoids numerous, lightly attached to the substratum. Lateral hairs are few in number, slender, translucent, distinctly septate, tapering, at the base 1.25–2 μ in diameter. Terminal hairs are of two types: (a) those which are short and arranged closely about the ostiole, septate and branched, at the base 3–4 μ in diameter, in general simulating a hat. (b) those which are long, unbranched and undulating, 4.25–5 μ in diameter, covered with very small barbules, tapering toward the apex, often reaching a length of 1800 μ. Asci clavate, eight-spored, 23 × 8 μ, spore part 18 μ. Mature asci are dilute brown, ovate to subglobose, 5 × 4 μ (4.75–5.25 × 3.0–4.5 μ).

This species is distinguished by the most delicate perithecium among the Chaetomia that the writer has observed. This fungus was sent to the writer by Dr. G. W. Martin and was designated as J-1334.

Chaetomium succineum sp. nov. Figs. 39–42.

Peritheciis magnitudinis mediae, globosis vel ovatis, 225–350 × 140–230 μ, ostiolatis, cirrhis frequenter provisis, rhizoideis tenellis ad substratum affixis. Pilis lateralibus numerosis, gracilibus, septatis. Pilis terminalibus numerosis, in cumulis autem laxiformibus, cirrhos fractos superportantibus. Pilis terminalibus gracilibus, diametro 3.5–4 μ basi, apicibus obtusis acuminatis, septatis, apice 1–3 convolutis laxis. Ascis clavatis, octosporis, 35 × 15 μ, parte sporifera 27 μ. Ascosporis maturis pallide olivaceo-brunneis, globoso-ovatis, utrinque rotundatis vel subacutis, 14 × 7.5 μ (12–15 × 7–8 μ).

Perithecia of medium size, globose to ovate, 225–350 × 140–230 μ, ostiolate, frequently provided with cirrhi, attached to the substratum with delicate rhizoids. Lateral hairs numerous, slender, septate. Terminal hairs numerous, of a beautiful amber color, formed in a loose cluster which holds fragmented cirrhi. Lateral hairs are graceful, 3.5–4 μ in diameter, septate, acuminate to a blunt apex which is coiled with 1–3 convolutions. Asci clavate, eight-spored, 35 × 15 μ, spore part 27 μ. Mature ascospores are of a pale olive-brown, globose-ovate, rounded to subacute at the ends, 14 × 7.5 μ (12–15 × 7–8 μ).

This species is distinguished by the loose cluster of slender amber-colored hairs which ornament the apex of the perithecium. The perithecia, in culture, are numerous but not crowded. Cultures were sent to the writer by Dr. G. W. Martin and by Mr. William B. Cooke, Pullman, Washington.

DISCUSSION

Type specimens of each species have been deposited at the Farlow Herbarium, Cambridge, Massachusetts, and co-types at the U. S. Department of Agriculture, Beltsville, Md.

Some of the species of *Chaetomium* described in this paper were isolated from rotting mattresses, tenting, knapsacks, clothing and other items of equipment from various islands in the Pacific combat areas. These plants were sent to the writer for identification and study by Dr. G. W. Martin and Miss Louise G. Isfort from the Jeffersonville Quartermaster Depot, Jeffersonville, Indiana. Several specimens were received from Mr. William B. Cooke, Pullman, Washington and Dr. Paul Marsh, Bureau of Plant Industry, Washington, D. C. For their kindness in sending the many specimens, and for the assistance of Dr. Hugh T. O'Neill at Catho-

lic University in revising my Latin descriptions, I wish to express my deep appreciation. Additional species, discovered by the writer, were found growing on material and equipment in the Tropical Testing Chamber, Fort Belvoir, Virginia. The first fungus belonging to the genus *Chaetomium,* as now understood, was described more than 131 years ago.

Kunze erected the genus *Chaetomium* in 1817 based upon the species *C. globosum;* a second species, *C. elatum,* was published by him a year later. In 1837 Corda emended Kunze's original description principally by describing the ostiolum; two new species, *C. indicum* and *C. murorum,* were added to the genus by him at that time. Descriptions of new species have appeared rather infrequently since the erection of the genus, and many of the later names have been determined subsequently to be synonyms or to have been erroneously applied. Three small monographic papers were published by Zopf (**1881**), Palliser (**1910**), and Bainier (**1910**). These were followed by a much more complete monographic treatment of the genera *Chaetomium* and *Ascotricha* in 1915 by Chivers. In this excellent monograph, of the 114 species and 14 varieties which were referred to the genus *Chaetomium,* he recognized only 28 species, 11 of which he described as new. Most of the species were beautifully illustrated, thus making identifications relatively easy and accurate. More recently, Tschudy (**1937**) described two species, *C. ochraceum* and *C. cancroideum,* which were isolated from decomposing reeds. In 1945 Hughes described a 4-spored species, *C. tetrasporum.* In the same year, Ames described three additional species, *C. dolichotrichum, C. microcephalum,* and *C. pachypodioides.* In a recent paper Skolko and Groves described two new species, *C. erectum* and *C. reflexum,* which were isolated from various types of seeds.

The species of *Chaetomium* described in this paper were grown in pure culture on the following medium:

$NaNO_3$	3.0 gms.
$MgSO_4 \cdot 7H_2O$	0.5 gm.
K_2HPO_4	1.0 gm.
KCl	0.2 gm.
Potato extract	50 ml.
Corn meal extract	50 ml.
Distilled water to make	1,000 ml.

On this medium strips of sterilized paper or 5 oz. cotton cloth were placed as a source of carbon. The cultures were grown in an incubation chamber maintained at a temperature of 85° F. and at a relative humidity of 85%. The same features of the species, as herein described, should be obtained when grown on the medium and under the conditions outlined. Some growth characteristics were observed, during the present study, which were not previously associated with the genus.

Conidia have not been authentically described hitherto for *Chaetomium* in spite of the fact that two closely related genera, *Chaetomidium* and *Ascotricha,* produce them abundantly. Recently, the writer has observed bulbils produced, in the agar medium, by one species, *C. gangligerum,* see figure 14. These bodies have not been fully investigated as yet to determine their reproductive capacity. A second species, *C. seminudum,* produces abundant bodies, see figures 28 and 29, borne apically and singly on slender branches, or occasionally they are of intercalary origin. These bodies are produced submerged in the agar culture medium in such numbers that the agar appears cloudy. These chlamydospore-like bodies will be studied more critically and reported on subsequently.

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EXPLANATION OF FIGURES

FIGS. 1 and 2, mature perithecia of *C. turgidopilosum;* 3, detail of a terminal hair; 4 and 5, ascus and ascospores; 6, mature perithecium of *C. cristatum;* 7, ascus with contained ascospores; 8, detail of type (a) terminal hair; 9, mature ascospores; 10, mature perithecium of *C. gangligerum;* 11, ascus with contained ascospores; 12, detail of terminal hair; 13, mature ascospores; 14, detail of "knots" or bulbil development; 15, mature perithecium of *C. velutinum;* 16, ascus with contained ascospores; 17, detail of terminal hair; 18, mature ascospores; 19, mature perithecium of *C. atrobrunneum;* 20, detail of branched terminal hair; 21, mature ascospores; 22, ascus with contained ascospores; 23, mature perithecium of *C. seminudum;* 24, detail of perithecium apex; 25, immature ascus; 26, mature ascospores enlarged by oil mount and 15 × eye piece; 27, hairs from agar surface; 28 and 29, chlamydospore-like bodies enlarged by oil mount and 15 × eye piece; 30, mature perithecium of *C. cupreum;* 31, ascus with contained ascospores; 32, mature ascospores; 33, detail of terminal hair; 34 and 35, mature perithecia of *C. causiaeformis;* 36, ascus with contained ascospores; 37, mature ascospores; 38, detail of short terminal hair surrounding the ostiole; 39, mature perithecium of *C. succineum;* 40, ascus with contained ascospores; 41, mature ascospores; 42, detail of terminal hair.

WYNNEA AMERICANA

Richard P. Korf

(with 1 figure)

One of the rarer Operculate Discomycetes is *Wynnea americana* Thaxter, easily recognizable by the many spoon-shaped apothecia arising from a fleshy, hypogeous "sclerotium" (fig. 1), the characteristically striate spores, and the eccentric ascus operculum. This short note is a report of some collections from New York and from West Virginia, extending the known range of this species.

In a recent and excellent paper, Le Gal (**2**) has discussed the morphology of the ascus tip in this and several other related fungi which comprise a new group, the Suboperculates, somewhat intermediate between Operculates and Inoperculates. Her treatment covers representatives of *Plectania* (sub *Sarcoscypha*), *Cookeina, Phillipsia, Pithya, Urnula, Rhizopodella* (sub *Urnula*), *Bulgaria* (sub *Sarcosoma*), *Pseudoplectania, Melascypha,* and *Wynnea*. In an earlier paper (**3**), delayed in publication, she had united these same genera into the family Sarcoscyphaceae, stressing spore ornamentation. Dr. Le Gal's disposition of these forms seems most natural, and the writer's observations have thus far been in full accord with hers.

Wynnea americana is known from several North American localities, including Tennessee, North Carolina, Ohio, and southern Pennsylvania (**4**). More recently it has been reported from additional Pennsylvania stations (**1, 5**).

Several unrecorded collections extend the northerly range of this species approximately sixty miles beyond the known limit at Meadville, Crawford County, Pennsylvania (**4**). Three collections made in the Lloyd-Cornell Preserve at Ringwood, New York, about seven miles east of Ithaca, are the most northerly collections known to the writer. Two collections from West Virginia, kindly communicated by Dr. H. L. Barnett, are also reported here.

FIG. 1. *Wynnea americana* Thaxter. Photograph, natural size, of a clump of apothecia; the soil surface was at the constriction just above the "sclerotium."

The specimens examined which extend the known distribution are deposited as follows:

NEW YORK—Gordon, Rea, et al., *Big Basin Forest, Allegany State Park, Cattaraugus Co., Aug. 16, 1935:* NYBG.—H. M. Fitzpatrick and C. T. Rogerson, *Ringwood, Tompkins Co., Sept. 26, 1947:* CTR; RPK.—R. E. Perkins and R. P. Korf, *same locality, Sept. 27, 1947:* CU-P 37137; NYBG; RPK.—do., *another collection:* RPK.

WEST VIRGINIA—H. L. Barnett, *Cooper Rock State Forest, Monongalia Co., August 30, 1947:* WVU.—W. C. Legg, *Mt. Lookout, Nicholas Co., November 1947:* WVU.

The writer wishes to express his appreciation to Mr. W. R. Fisher, who made the excellent photograph accompanying this note (CU-P 37137). In this specimen the hymenium was a light rose-pink color, much lighter than that usually ascribed to this species. The other two collections from Ringwood were well past their prime, and some deterioration had already occurred; in these the hymenial color was a deep purple-red. They more closely approximated the appearance of the photograph in the book by Dr. Seaver (**5**: plate 16), to whom the writer is indebted for the loan of material from the New York Botanical Garden.

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CYATHUS VERNICOSUS, ANOTHER TETRA-POLAR BIRD'S NEST FUNGUS

HAROLD J. BRODIE

(WITH 2 FIGURES)

The recent studies of Dr. Nils Fries of Sweden and of the writer concerning sexuality in the Nidulariaceae have shown that all species thus far examined are heterothallic and tetrapolar. The species of this group of fungi for which four-mating-type heterothallism has been established are:

Crucibulum vulgare Tul. .... Fries, 1936 (3)
Cyathus stercoreus Schw. (De Toni) .... Brodie, 1948 (1, 2)
Cyathus striatus Willd. .... Fries, 1936 (3)
Nidularia pisiformis (Roth.) Zell. .... Fries, 1948 (4)

To this list may now be added *Cyathus vernicosus* DC. This fungus is of fairly common occurrence in gardens, where it often grows among dead plant stems or around board edging. In greenhouses it has been found on flats of soil. The species is readily recognized by its buff-grey color, wide flaring mouth and large peridioles (FIG. 2). The inside surface of the cup usually has a shiny or varnished appearance.

In 1920, Dr. Leva Walker (**5**) published an account of *C. vernicosus* mainly from the point of view of the developmental morphology of the fruit body. It was shown that basidiospores contain two nuclei and that two nuclei are regularly present in each cell of the diploid mycelium which bears clamp connections. Since Miss Walker did not succeed in obtaining a series of monosporous mycelia, the question of whether the fungus is homothallic or heterothallic was left unanswered.

By growing diploid mycelium on sterile loam, old leaves and half-rotten wood, Miss Walker obtained fruit bodies in the laboratory and full details of every step in the development of the fruit bodies and their peridioles were described.

MATERIALS AND METHODS

The first attempt made by the writer to culture this fungus was in 1941. An abundant supply of fruit bodies was found in a garden in Winnipeg, Canada, where the little cups were growing around the bases of dead chrysanthemum stalks. Spores from chopped peridioles were placed in distilled water and in various nutrient solutions at room temperature. So few spores (1–3%) germinated in any test that the attempt to obtain a series of monosporous mycelia was abandoned. Several efforts were made subsequently to germinate enough spores for study, but always with the same unsatisfactory result. Similar difficulty was reported by Miss Walker (**5**).

When it had been learned that the basidiospores of *Cyathus stercoreus* germinate well after being subjected to a temperature of 40° C. for 48 hrs.—see Brodie, 1948 (**1**)—fresh material of *C. vernicosus* was sought. The writer is indebted to Mr. Garnet Best of Winnipeg, Canada, for three fruit bodies collected by him in that city, Oct. 19, 1947. These specimens provided the single-spore cultures used in the present investigation.

The spores were not tested for germinability until Nov. 19, 1948, exactly a year after the fruit bodies had been collected. Peridioles were cut open under aseptic conditions and spores in a distilled water suspension were incubated at 40° C. for 48 hours, using exactly the same technique as has been described by the writer (**1**) in his report on *C. stercoreus*.

Plate dilutions were made and single spores cut out under the microscope. The mycelia that developed were transferred to tube slants of a special medium compounded as follows: Bacto agar, 20 gm.; maltose, 5 gm.; dextrose, 2 gm.; glycerine, 2 gm.; peptone, 0.2 gm.; asparagine, 0.2 gm.; yeast extract, 2 gm.; magnesium sulphate, 0.5 gm.; calcium nitrate, 0.5 gm.; dihydrogen potassium phosphate, 0.5 gm.; ferrous sulphate, trace; distilled water to make 1 liter.[1] Using this medium, optimum vegetative growth at room

[1] Two of the ingredients were inadvertently omitted from the formula as given in a previous article (*2*) and the corrected formula is therefore given herewith.

temperature was obtained when the acidity of the medium was adjusted to pH 6.5.

Sixty monospore mycelia were isolated but only twenty-nine of these were used in the study of pairing reactions.

SPORE GERMINATION AND HAPLOID MYCELIA

The basidiospores of *C. vernicosus* are moderately thin-walled, colorless and (in the collection referred to above) measure mostly $7 \times 11\ \mu$. Spores began to germinate 24 hours after the heat treatment, but some germinated tardily a day later. From 40–60% of the spores germinated in each of the different spore samples. A single stout germ tube developed from each spore and this rapidly grew into a haploid mycelium.

Haploid mycelia growing on agar plates are fluffy and fine-textured. Of twenty-nine, selected at random for pairing, only six showed any tendency to produce the coarse mycelial cords characteristic of the diploid mycelia, the rest remained fine-textured throughout numerous transfers.

Haploid mycelia show only slight morphological differences when monospore cultures are compared. As to color, they are all snow-white when freshly transferred and most of them become a dull ivory color about two weeks later. Four of the series of the original sixty isolates were buffy brown (Ridgway). No attempt has been made to study the inheritance of color because the color differences between haploids are not so striking as they are in *C. stercoreus*, nor are the colors so constant from transfer to transfer.

No haploid mycelium has been observed to produce oidia nor to produce fruit bodies in culture.

PAIRING REACTIONS AND DIPLOID MYCELIUM

Twenty-nine haploid mycelia were paired in all possible combinations in the usual way on agar slants. Diploid mycelium began to develop between certain pairs ten days later. All mycelial pairs were examined for clamp connections at the end of two weeks. On the basis of their mating reactions, the haploid mycelia fell into four mating types with the following distribution:

Mating type	Culture number[2]
AB	1, 4, 5, 7, 15, 16, 20, 29
ab	2, 8, 14, 24, 27
Ab	3, 6, 10, 13, 17, 19, 21, 22, 23, 25, 26, 28, 30
aB	12, 18

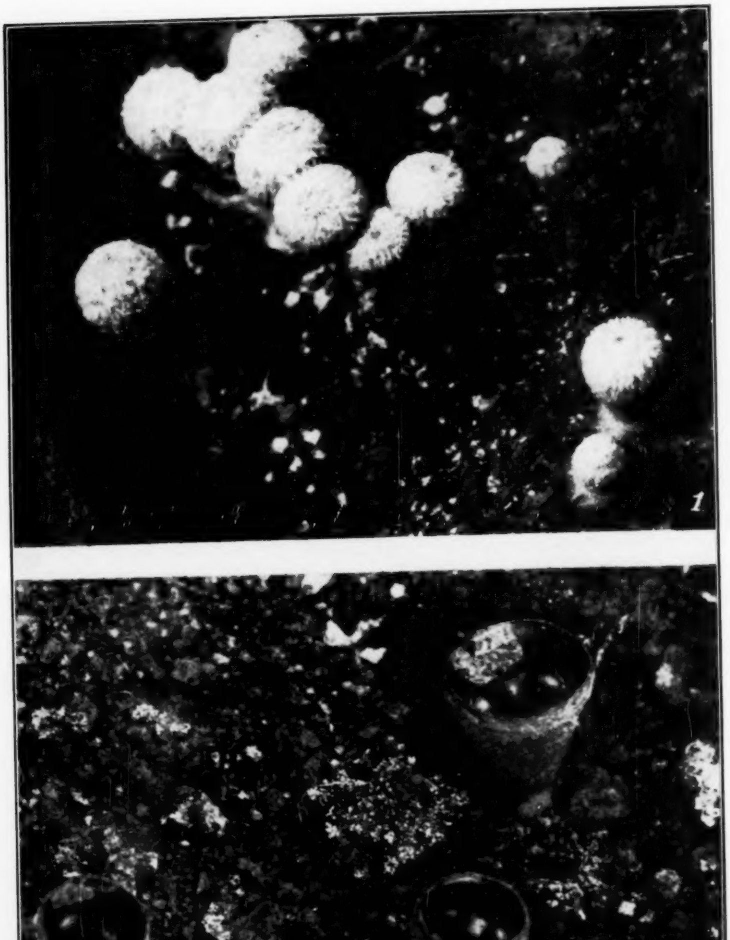
It would thus appear that *Cyathus vernicosus,* like all other members of the Nidulariaceae examined up to the present time, is heterothallic and tetrapolar. The distribution of haploid mycelia among the four sex groups is very unequal, similar to the distribution previously noticed by the writer (**1**) in *C. stercoreus.* From a small number of pairings, this might be considered to have no special significance. However, Dr. Nils Fries has informed the writer (by letter) that he attempted an analysis of sexuality of the European *C. olla* (Batsch) Pers. (*C. vernicosus*) and found that 23 monosporous mycelia fell into four groups in the ratio of 1 : 11 : 10 : 1. Because two groups were represented by only one mycelium each, Fries did not publish his results. Fries' finding furnishes corroboration for the present writer's opinion that this unequal distribution is a common occurrence and that there is some factor operative in determining the unequal distribution of mycelia as to mating type. This may well be similar to what has been observed in *C. stercoreus* (**1**).

Diploid mycelia bearing clamp connections are mostly white or pale ivory in color and are composed of hyphae that are somewhat coarser than are those of haploid mycelia. The hyphae of the diploid mycelium tend to become aggregated into loose ropes or cords, which give to a colony on an agar plate a characteristic radiate appearance. Some coarse mycelial cords form as colonies get older, and on these the fruit body rudiments develop. Cords of this kind are not as abundant on the diploid mycelium of *C. vernicosus* as they are on *C. stercoreus* mycelium.

PRODUCTION OF FRUIT BODIES IN CULTURE

Whereas the addition of filter paper as a source of cellulose to the special medium referred to above induced abundant normal fruiting of *C. stercoreus* (**1**, **2**), this procedure failed to cause the

[2] Culture No. 9 was eliminated from the series when it failed to continue growth after two transfers.



FIGS. 1–2. *Cyathus vernicosus.*

mycelia of *C. vernicosus* to fruit. Even the development of knots on the mycelium that indicates the beginning of fruit body formation took place only on three cultures that were six weeks old and none of the knots continued to grow.

Cultures were then transferred to sterilized mixtures of old leaves, rotting wood, etc., following Miss Walker's (**5**) suggestion, but in no instance did fruit bodies appear on any culture although some of these were kept for three months.

Finally it was decided to resort to the use of soil. Mycelium (and agar medium) from five slants in flasks, each culture a month old, was placed in a clean 8 in. flower pot. The culture material was then covered to a depth of one inch with a sifted sterilized loam mixture and the soil was pressed down gently.

One week later, mycelial strands appeared on the surface of the soil and a few fruit body rudiments were visible. By the end of another week, seventy fruit bodies had developed on the culture, all of which opened normally in a few days (FIGS. 1, 2).

Regarding this rapid development of fruit bodies after the addition of soil, it seems unlikely that the soil could supply any nutritional deficiency which could induce fruiting so soon after application. It appears more probable that aeration (texture of the medium, etc.) was not properly provided by the agar slants but was provided by the loose covering of soil. To date, several other cultures of *C. vernicosus* have been induced to fruit in this way, but other methods have proven unsuccessful.

Although several diploid mycelia, each representing combinations of different haploid mycelia, have been fruited, there is little variation in the morphology of the fruit bodies: nothing comparable to the extreme variability characteristic of *C. stercoreus* fruit bodies has been observed.

Most detail concerning the morphology of the fruit bodies is being reserved for future publication. However, because the photographs illustrate two noteworthy features of this species, attention may be drawn briefly to these. It is not generally recognized that fruit bodies of *C. vernicosus* develop a basal mass of hyphae (the so-called "emplacement") comparable with the large and conspicuous ball found at the base of the fruit body of such species as *C. striatus* and *C. stercoreus*. In *C. vernicosus* this

emplacement develops early and may be seen as a mycelial mat around the base of a young fruit body (FIG. 1). As development proceeds, soil becomes incorporated into the emplacement so that its size and full extent are appreciated only when soil is lifted from below the base of the cup.

The epiphragm or covering over the mouth of the unopened fruit body usually ruptures by an irregular tear across the diameter in *C. striatus* and *C. stercoreus*. The epiphragm of all specimens of *C. vernicosus* developed in the writer's cultures seemed to rupture in a circumscissile manner, the epiphragm withdrawing as a shrunken disk to one side of the peridium (FIG. 2).

SUMMARY

1. Basidiospores of *Cyathus vernicosus* were germinated one year after collection by subjecting them to a temperature of 40° C. for 48 hrs. in distilled water suspension.

2. Sixty single-spore mycelia were cultured, of which 29 were used in a study of heterothallism.

3. Single-spore mycelia are haploid. The mycelia are quite uniformly white and fluffy, an occasional one showing grey-brown coloration.

4. When paired, haploid mycelia fall into four mating-type groups with uneven distribution of mycelia in the groups. The fungus is heterothallic and tetrapolar.

5. Diploid hyphae bear clamp connections and tend to become aggregated into cords upon which fruit body rudiments arise.

6. Diploid mycelia were induced to fruit only by covering cultures on agar slants with an inch of sterile soil.

7. Each fruit body of *C. vernicosus* has an "emplacement" or mass of basal hyphae which becomes compacted into a solid ball within the soil. This structure is similar to the emplacements of *C. striatus* and *C. stercoreus*.

8. The epiphragm of *C. vernicosus* ruptures most frequently in a circumscissile manner and withdraws to one side of the cup as a shrunken disk.

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DESCRIPTIONS OF ILLUSTRATIONS

FIG. 1. Young unopened fruit bodies of *Cyathus vernicosus* developed on an agar culture which had been covered two weeks before by one inch of sterile soil. Two young specimens in the lower right show the early development of the basal emplacement hyphae. $\times 2$.

FIG. 2. Fruit bodies of *Cyathus vernicosus* a few hours after they had opened. The epiphragm in the largest specimen had withdrawn to the side of the mouth where it remained as a shrunken disk. As specimens get older, the mouth tends to flare outward more than in these young specimens. $\times 2$.

STUDIES IN THE GENUS OTIDEA *

Bessie B. Kanouse

(with 21 figures)

During the collecting season of 1948, from late June to October, the University of Michigan maintained a botanical expedition in Mt. Rainier National Park, Washington. Dr. A. H. Smith who conducted the survey was assisted by Henry A. Imshaug and Emory G. Simmons. Dr. D. E. Stuntz of the Department of Botany, University of Washington, joined the group in July. They obtained abundant collections of *Otidea* species which, with the collections in the University of Michigan Herbarium, form the basis of this investigation. The writer recognizes ten species and three varieties. This number materially exceeds the number in previous published reports for North America. Seaver (**1928**) reported three under the name *Scodellina.* One new species, *O. rainierensis,* and one new variety, *O. alutacea* var. *microspora,* are described from the Mt. Rainier collections and one new species, *O. Kauffmanii,* is named from Michigan material. The types of new species described here are deposited in the University Herbarium of the University of Michigan.

The genus *Otidea* was established by Fuckel (**1869–1870**) for *Peziza leporina* Pers. ex Fr., *P. onotica* Fr., *P. cochleata* L. and *P. abietina* Pers. The principal diagnostic character by which species of *Otidea* differ from those in *Peziza* is the presence of a split in the apothecium. Fuckel (l.c.) in his diagnosis of the genus described the paraphyses as "filiform subclavate" although he included *O. leporina* and *O. onotica* in which the paraphyses are hooked and not subclavate. Since the genus was established, several species which have filiform or filiform-subclavate paraphyses have been described for it. Boudier (**1885**) considered the straight paraphyses as distinctive and established the genus *Wynnella* based in part on such paraphyses. *O. auricula* Schaeff. was

* Papers from the Herbarium of the University of Michigan.

made the type of *Wynnella*. Rehm (**1887–1896**) reduced this genus to subgeneric rank. The writer does not regard *Wynnella* as sufficiently different from *Otidea* to consider it as a genus.

The paraphyses in the two new species described in this paper exhibit a third type for the genus. In both of these they are filiform and the apices are expanded into broadly clavate, pyriform or globose to subglobose heads. No previously described species of *Otidea* with this type of paraphysis is known to the writer. *O. fibrillosa* (Currey) Mass. was so described, but the fungus is not an *Otidea*. The spores are described as eguttulate, and the exterior of the apothecia as tomentose. As illustrated by Cooke (**1879**) the apothecia are not split. Our species are obviously not to be considered *O. fibrillosa*. Besides the split apothecia other characters that *Otidea* species have in common are: elliptical biguttulate (rarely uniguttulate) spores, absence of blue coloration in iodine solution, and the prosenchymatic structure of the hypothecium. The excipular layer shows variation but no more than might be expected as differences at the species level. In general this layer is composed of hyphae which are divided into cells so as to give a pseudoparenchymatic appearance. The cells are subglobose, hexagonal to long cylindrical, and exhibit many irregularities of shape and size. This layer may be relatively thick —up to 300 μ, or as narrow as 50 μ. It is yellowish to brownish yellow in color. The transition from the hypothecial layer is usually gradual but it may be sharply differentiated, as it is in *O. auricula*. The outermost layer in some species is fairly even, as in *O. Cantharella* v. *minor* Boud., but in most species the hyphal ends are gathered up into small pyramidal aggregations frequently with short protruding chains of from three to six cells. Such chains are found in connection with the aggregations of hyphae or they may arise from a surface that does not produce the conspicuous bunches of cells. The surface cells are not sufficiently developed to produce more than a very slight tomentosity on the cup proper. The basal portion of the cup and the stipe may be definitely tomentose. In *O. auricula* as represented in the North American collection cited in this paper, the outermost layer is a definite palisade layer of elongate cells rounded at their apices (FIG. 7). Such a distinct palisade layer has not been found

in other species studied by the author nor has reference to it been seen in the literature except in Massee's description of *O. neglecta.* The reader is referred to the remarks concerning this situation in the discussion following *O. auricula.* In *O. grandis* and *O. Smithii* there exists a condition that is peculiar to these species. The excipular layer is covered with minute, subglobose granules golden brown in color. They give the excipular cells a scurfy appearance and emphasize the brown color, and, in *O. grandis,* the mealy texture of the outside of the apothecia. In a water mount they become detached easily. Boudier (**1905–1910**) illustrated them for *O. umbrina,* but referred to them only in the description of the plate. They were found in all of the collections of *O. Smithii* and *O. grandis* examined by the author.

OTIDEA (Fr.) Fuckel

Apothecia sessile to stipitate, gregarious, often cespitose, occasionally fused at their bases, size varying, from 1 cm. to 10 cm. in height, elongate to ear-shaped or truncate, split to the base on one side, glabrous to furfuraceous, hypothecium prosenchymatic, exciple pseudoparenchymatic; asci cylindrical, 8-spored; spores usually smooth, biguttulate (infrequently uniguttulate); paraphyses filiform and frequently branched below, apices straight, bent, hooked, clavate, or globose; no blue color reaction in iodine.

Type of the genus: *Otidea leporina* (Fr.) Fuckel.

KEY TO SPECIES

1. Paraphyses hooked or bent at their apices 2
1. Paraphyses not hooked or bent at their apices 8
2. Apothecia typically ear- or spoon-shaped 3
2. Apothecia truncate, not ear-shaped 6
3. Apothecia large, deep vinaceous brown, concolorous .... *O. Smithii*
3. Apothecia some shade of yellow or yellow-brown 4
4. Apothecia bright yellow with rosy tints to the hymenium; spores 12–14 × 6–7 (8) μ .... *O. onotica*
4. Apothecia lacking rosy tints in hymenium 5
5. Apothecia medium to large, clear yellow; spores 10–12 (13) × 5–6 μ.... *O. concinna*
5. Apothecia medium sized, dull yellowish brown; spores 12–14 × 6–8 μ.... *O leporina* v. *typica*
5. As above but spores 8–11 × 5–6 μ .... *O. leporina* v. *minor*

6. Apothecia usually densely cespitose, medium to large, alutaceous outside, wood-brown inside; spores 14–16 × 7–9 μ..........*O. alutacea* v. *typica*
6. As above but spores 9–11 × 5.5–6.5 μ..........*O. alutacea* v. *microspora*
6. Apothecia not alutaceous in color..............................7
7. Apothecia small to medium, exterior dark brown, mealy; spores 14–17 × 6–7 μ..*O. grandis*
7. Apothecia small, dull brownish yellow; spores 10–11 (12) × 6–7 μ..... *O. Cantharella* v. *minor*
8. Paraphyses not enlarged at apices; apothecia large, ear-shaped, red-brown, mahogany outside, nearly concolorous within; spores 23–25 × 12–16 μ... *O. auricula*
8. Paraphyses with apices enlarged..................................9
9. Paraphyses with broadly clavate to subglobose heads...............10
9. Paraphyses with numerous notched branchlets near apices..*O. abietina*
10. Apothecia large, wood-brown outside, drab gray inside................ *O rainierensis* sp. nov.
10. Apothecia small, yellowish tan to yellowish buff, concolorous......... *O. Kauffmanii* sp. nov.

OTIDEA LEPORINA (Fr.) Fuck. var. TYPICA (FIGS. 1, 2).

Apothecia gregarious or cespitose, usually elongate–ear-shaped, split to the base on the short side, 1–4 cm. in height, 1–3 cm. in width, narrowed below into a stipe variable in length up to 6 mm. long, outside "hazel" (R.)* to "cinnamon rufus" (dry), inside "wood brown," "avellaneous" to "Sayal brown" (dry), stipe creamy white; hypothecium composed of hyaline hyphae interwoven; excipular layer thin (50–75 μ), composed of irregularly arranged subglobose to polygonal cells yellowish in color, the outermost layer giving rise to short chains and aggregations of cells; asci cylindrical, 140–170 × 10–12 μ, 8-spored, not turning blue in iodine; spores elliptical, smooth, slightly colored yellowish, 12–14 × 6–8 μ, biguttulate; paraphyses filiform, hyaline, apices slightly thickened, hooked.

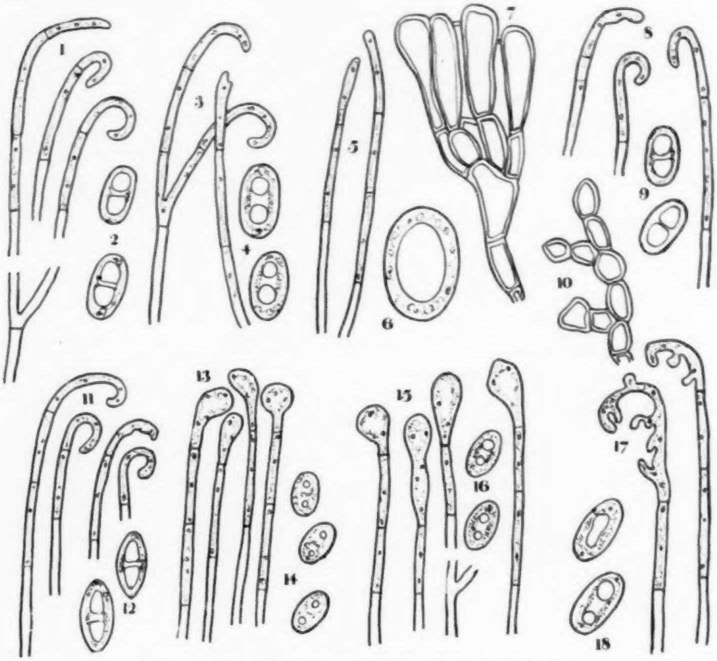
HABITAT: On ground.

DISTRIBUTION: Colorado, Maryland, New York, Oregon, Washington.

MATERIAL EXAMINED: Rehm, Ascomyceten *1627a, 1627b;* C. A. Brown, Lake Quinault, Wash., Oct. 11 and Oct. 13, 1925; F. B. Cotner, Tolland, Colo., Aug. 27 and Aug. 28, 1920; J. B. Flett, Bremerton, Wash., Oct. 26, 1942; W. Haydon, Marshfield, Ore., Oct. 12, 1914; C. H. Kauffman and E. B. Mains, Lake Placid, New York, Sept. 10, 1914; C. H. Kauffman, Lake Cushman, Wash., Oct. 2, 1915; Cabin John, Md., Aug. 22, 1919;

* Ridgway, R., 1912. Color Standards and Color Nomenclature, Washington, D. C.

Tolland, Colo., Aug. 27, 1920; Lake Quinault, Wash., Oct. 11 and Oct. 13, 1925; Takilma, Ore., Dec. 10, 1925; E. G. Simmons, Longmire, Wash., Sept. 4, 1948, *2172;* A. H. Smith, Lake Crescent, Wash., Oct. 28, 1935, *3380;* Lake Tahkenitch, Ore., Nov. 21, 1935, *3585;* Lower Nisqually River, Wash., Sept. 2, 1948, *30888*, Nancy Jane Smith, Longmire, Wash., Aug. 26, 1948 (A. H. Smith *30664*); L. E. Wehmeyer, Mt. Hood, Ore., Oct. 15, 1922.



FIGS. 1–18. Microscopic characters in *Otidea.*

OTIDEA LEPORINA (Fr.) Fuck. var. MINOR (Rehm) Sacc. Syll. Fung. **8**: 94. 1889.

Like var. *typica* except that the asci and spores are smaller. The spores measure 8–11 × 5–6 μ.

HABITAT: On ground.

DISTRIBUTION: California, Michigan, New York, Oregon, Washington.

MATERIAL EXAMINED: C. H. Kauffman, Takilma, Ore., Nov. 29, and Dec. 10, 1925; C. H. Kauffman and Ethel Taylor, Marquette, Mich., Aug. 27, 1909; C. H. Kauffman and E. B. Mains, Chelsea, Mich., Aug. 2, 1915;

C. H. Kauffman and C. A. Brown, Takilma, Ore., Dec. 7 and Dec. 10, 1925; E. B. Mains, Rock River, Mich., Aug. 20, 1932, *32–177;* Baker Lake, Wash., Aug. 31, 1941, *6180;* A. H. Smith, Warrensburg, N. Y., Sept. 14, 1934, *1002;* Crescent Beach, Wash., Sept. 24, 1935, *2594;* Trinidad, Calif., Nov. 30, 1935, *3690;* Whitmore Lake, Mich., Sept. 26, 1936, *4929;* George Reserve, Pinckney, Mich., July 7, 1937, *6454;* Lower Tahoma Creek, Wash., Aug. 20, 1948, *30372;* L. E. Wehmeyer, Mt. Hood, Ore., Sept. 28, and Oct. 1922.

OTIDEA ONOTICA (Fr.) Fuck. Symb. Myc. 329. 1869–70. (FIGS. 10, 19).

Apothecia gregarious, often cespitose, substipitate to stipitate, elongate, typically spoon- or ear-shaped, margin involute, divided to the base on one side, arising from a mass of debris held together with mycelium, base white tomentose, 6–10 cm. in height, 5–6 cm. in width (wider if expanded), externally "ochraceous

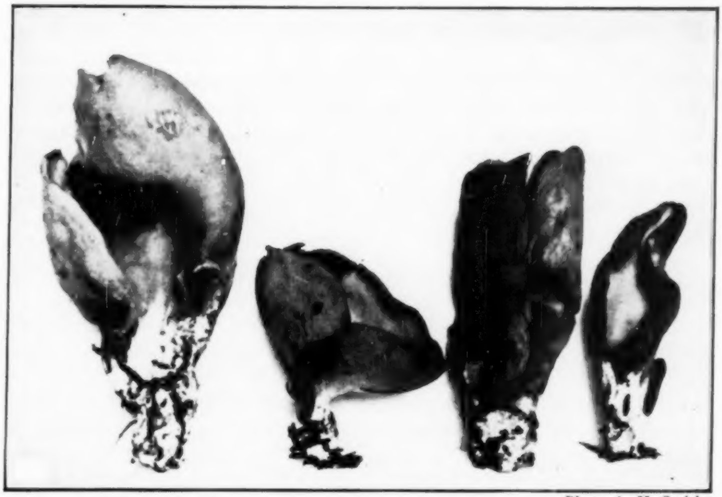


Photo A. H. Smith.

FIG. 19. *Otidea onotica.* × ½.

orange," "cinnamon," "orange buff" (dry), interior "pinkish cinnamon," "ochraceous buff" to "apricot buff" with tints of rose; hypothecium composed of hyaline hyphae densely interwoven; excipular layer 50 μ in thickness, composed of large cell-like hyphae from the outermost layer of which arise chains and irregular groups of cells; asci cylindrical, 160–200 × 9–11 μ, not turning blue in iodine; spores elliptical, obliquely uniseriate, hyaline or colored faintly yellowish, smooth, biguttulate, 12–14 ×

6–7 (8) μ; paraphyses filiform, usually strongly hooked, frequently forked below.

HABITAT: On the ground, usually in conifer forests.

DISTRIBUTION: California, Michigan, New Hampshire, Oregon, Washington.

DISCUSSION: The apothecia are larger and more brightly colored than in *O. leporina*. Since the time of Fries mention has been made of the rosy color present in the inside of the cups. It is strongly indicated even in dry specimens. The depth of color frequently approaches "zinc-orange." *O. leporina*, with which it has been confused, is duller in color and seldom approaches the size of *O. onotica*.

MATERIAL EXAMINED: H. A. Imshaug, Nisqually River, Wash., Aug. 30, 1948, *2116;* C. H. Kauffman and C. A. Brown, Takilma, Ore., Dec. 2, 1925; E. B. Mains, Randolph, N. H., Aug. 19, 1938, *4205;* Sept. 5, 1937, *4180;* E. G. Simmons, Lower Tahoma, Wash., Sept. 5, 1948, *2178;* A. H. Smith, LakeTahkenitch, Ore., Nov. 10, 1935, *3414;* Belknap Springs, Ore., Oct. 23, 1937, *8127;* Milford, Mich., July 2, 1940, *15166;* Chelsea, Mich., July 31, 1937, *6719;* Oregon Caves, Ore., Dec. 1, 1937, *9322;* Lower Tahoma Creek, Wash., Aug. 22, *30441,* Aug. 25, *30579,* Aug. 27, *30674,* Sept. 8, 1948, *30990,* Sept. 20, 1948, *31544;* Helen Smith, California Line, Nov. 20, 1937; A. H. Smith, Smith River, Calif., Oct. 16, 1937, *8940;* L. E. Wehmeyer, Oct. 13, 1922.

Otidea concinna (Pers. ex Fr.) Sacc. Syll. **8**: 96. 1889.

Apothecia solitary to cespitose, truncate, strongly folded into convolutions, arising from a stout stem-like base, 2–3 cm. high, 3–4 cm. wide, color "pinkish cinnamon" to "Sayal brown" (dry) with a suggestion of yellow (said to be clear yellow when fresh), concolorous, whitish tomentose below; hypothecium composed of coarse, loosely woven hyaline hyphae; excipular layer narrow, pseudoparenchymatic, outer surface of large cell-like segments irregularly arranged, chains of cells present; asci cylindrical, 125–175 × 8–10 μ, 8-spored, not turning blue in iodine; spores elliptical, 10–12 (13) × 5–6 μ slightly colored yellowish, smooth, biguttulate; paraphyses filiform, sometimes forked below, apices hooked or bent.

HABITAT: On the ground.

DISTRIBUTION: Idaho, Washington, Sweden.

DISCUSSION: This species is represented for North America in the University of Michigan Herbarium by three collections. These

collections and that of Rehm: Ascomyceten No. 1628 are indistinguishable in the dry condition as well as in their microscopical characters. The cups are much folded. One cup in the Idaho collection was measured after being soaked in water and the ruffled edge measured 20 cm. in circumference. Letellier (1829–1842) has an excellent illustration of this fungus.

MATERIAL EXAMINED: Rehm: Ascomyceten *1628* Sweden. Mycobiota of North America, Wm. B. Cooke, Latah Co., Idaho, *285* (distributed as *O. leporina*); H. A. Imshaug, Nisqually River, Wash., Aug. 30, 1948, *2127;* E. G. Simmons, Fish Creek, Mt. Rainier Nat. Park, Wash., Aug. 25, 1948, *2067.*

OTIDEA CANTHARELLA var. MINOR Boud. Icon. Myc. 4, p. 181. 1905–1910. Vol. 2, pl. 326.

Apothecia solitary to gregarious, small, 1–1.5 cm. in height, 1–2.5 cm. broad, truncate, split on the short side to the base, edges of split enrolled, pale yellow outside, concolorous, drying "ochraceous buff" to "light ochraceous buff," substipitate, creamy white below (dry); hypothecium composed of hyaline hyphae densely interwoven; excipulum pseudoparenchymatic, cell-like hyphae thick-walled, yellowish, forming a fairly regular outer layer, not arranged in aggregations, palisades or chains; asci cylindrical, 140–160 × 10–12 μ, 8-spored, not turning blue in iodine; spores elliptical, smooth, biguttulate, 10–11 (12) × 6–7 μ, obliquely arranged in the asci; paraphyses filiform, hyaline, septate, branched below, apices bent or hooked, slightly thickened above and reaching 3 μ in width.

HABITAT: On the ground.

DISTRIBUTION: Colorado, Washington.

MATERIAL EXAMINED: E. B. Mains, Wild Basin, Rocky Mountain National Park, Colo., Sept. 1, 1940, *5270;* A. H. Smith, Lower Tahoma Creek, Wash., Sept. 8, 1948, *31033.*

OTIDEA ALUTACEA (Fr.) Bres. var. TYPICA (FIGS. 3–4, 20).

Apothecia cespitose, frequently in large dense clusters, irregularly contorted, bases sometimes joined, infrequently solitary, truncate, sub-sessile or short stipitate, 2–6 cm. in height, 2–4 cm. in width, smooth, glabrous, drying wrinkled, exterior "tawny olive," "pinkish buff" or "cinnamon buff" to "clay color," "wood brown" (dry); hymenium "avellaneous" to "wood brown" (fresh), fragile; hypothecium composed of hyaline hyphae densely interwoven;

excipular layer pseudoparenchymatic, up to 200 μ thick, cell-like unit subglobose, yellowish, ending in a narrow marginal layer of irregular chains and loosely arranged groups of hyphal segments; asci cylindrical, 150–200 (250) × 8–10 μ, not turning blue in iodine; spores narrowly elliptical, smooth, 14–16 × 7–9 μ, biguttulate, slightly colored yellowish, uniseriate or obliquely arranged in the asci; paraphyses filiform, occasionally branched below one or two times, septate, hyaline, apices hooked.

HABITAT: On ground in coniferous forests.

DISTRIBUTION: California, Washington.

MATERIAL EXAMINED: Mycobiota of North America, Wm. Bridge Cooke *284* (distributed as *Otidea grandis*); H. A. Imshaug, Lower Tahoma Creek, Wash., *759, 830, 849, 859, 965, 1124, 1125, 1225;* E. G. Simmons, Longmire, Wash., July 28, 1948, *1722,* Aug. 30, 1948, *2106, 2108;* A. H. Smith, Olympic Nat. Park, Wash., Sept. 27, 1941, *17338* (reported by the writer (**1947**) provisionally as *O. felina.*); Lower Tahoma Creek, Wash., July 31 to Aug. 23, 1948, *29284, 29295, 29299, 29302, 29411, 29416, 29418, 29507, 29538, 29547, 29595, 29615, 29672, 29714, 29840, 29937, 30099, 30194, 30275, 30444, 30555, 31008, 31168;* Paul Rea, Santa Barbara Co., Calif., Dec. 31, 1941, *1081.*

Otidea alutacea var. **microspora** var. nov.

Apothecia solitaria aut caespitosa 5–8 cm. alta, truncata, pallide hyalino-flava, subtus albida, sicco pallide lutea usque roseo-lutea; sporis 9–10 ×

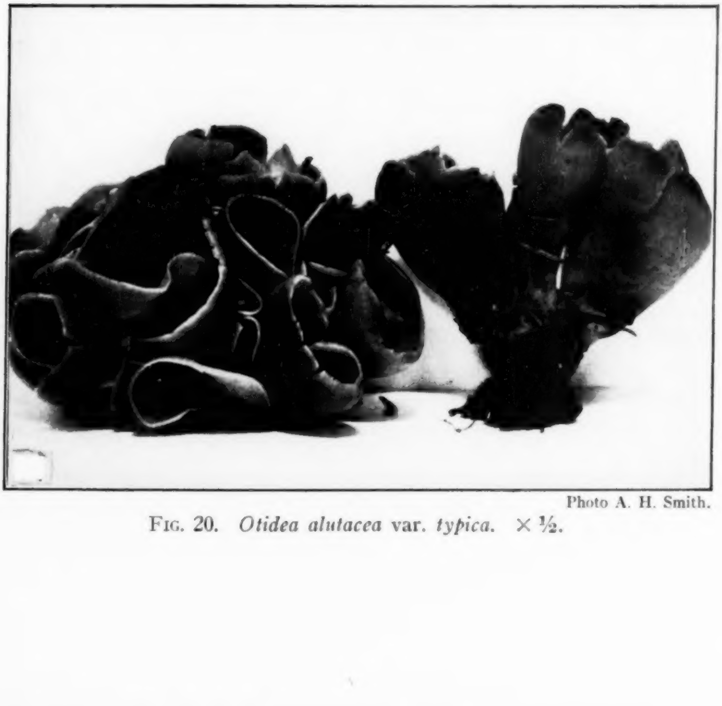


Photo A. H. Smith.

FIG. 20. *Otidea alutacea* var. *typica.* × ½.

5.5–6.5 (7) μ; hypothecio, excipulo, et paraphysibus varietatis typicae similibus.

Ad humum, Crescent City, Calif., 3 Dec. 1937. A. H. Smith. No. *9351*, Typus.

Apothecia solitary or cespitose, 5–8 cm. in height, truncate, pale clear yellow (fresh), whitish below, drying "pale buff" to "pinkish buff"; asci 175–200 × 7–10 μ, frequently with long rooting base, spores 9–10 × 5.5–6.5 μ; hypothecium thick, up to 350 μ; exciple thin; paraphyses with narrowly clavate apices, straight or hooked.

HABITAT: On ground.

DISTRIBUTION: California, Washington.

DISCUSSION: The differences between var. *typica* and var. *microspora* lie in the spore size and in the color of the apothecia. In var. *microspora* the color is paler and more yellow, and the spores are smaller.

MATERIAL EXAMINED: Olympic Hot Springs, Olympic Nat. Park, Wash., Oct. 8, 1941, A. H. Smith *17699*, **type**; reported by the writer (**1947**) provisionally as *O. felina* (Pers. ex Fr.) sensu Bres. A. H. Smith, Crescent City, Calif., Dec. 3, 1937, *9351;* Lower Tahoma Creek, Wash., Aug. 23, 1948, *30502.*

OTIDEA AURICULA (Cke.) Mass. Grev. **21**: 65. 1894 (FIGS. 5, 6, 7, 21).

Apothecia gregarious or solitary, narrowly elongate, ear-shaped, split on one side to the base, edges enrolled, stem-like base short, usually grooved, becoming horny when dry, 3–7 cm. in height, 1–2 cm. in width (3–4 cm. if flattened out), smooth, bay to chestnut brown shading to "clay color" at the base, margin sometimes "Sayal brown," inside darker, when dry dull purplish brown inside and outside; hypothecium composed of hyaline hyphae densely interwoven; excipular layer composed of pseudoparenchymatic hyphae, 100 μ in thickness, the outermost hyphal segments arranged in a definite palisade layer, elongated, ends rounded at the apices, containing brown coloring matter, color soluble in water; asci cylindrical, 300–400 × 15–18 μ, 8-spored, not turning blue in iodine; spores hyaline, smooth, containing one large central oil drop, 22–25 × 12–16 μ, uniseriate; paraphyses filiform, becoming clavate at the apices, 6 μ in diameter, containing brown coloring matter.

HABITAT: On the ground.

DISTRIBUTION: Michigan, Montana.

DISCUSSION: This species is not to be confused with a similar fungus which is white outside instead of brown. Massee has named the fungus with the white exterior *O. neglecta* Massee. The uniform yellowish brown color of the apothecia as observed in our collection is in accord with the interpretation of *O. auricula* sensu Massee. He based his concept of the species in part on the statement made by Schaeffer (**1763**) who described and illustrated a fungus which Massee interpreted as *O. auricula.* Rehm (**1887–1896**), Boudier (**1905–1910**), and Bresadola apply the specific

Photo C. H. Kauffman.

FIG. 21. *Otidea auricula.* × ½.

name *O. auricula* to fungi having a whitish exterior. Both Boudier and Bresadola have illustrated such apothecia. Massee stated that the hyphal structures of the two species were different; that the exciple in *O. auricula* was parenchymatic while in *O. neglecta* the outermost cells were arranged parallel. Our North American collections have the dark color accorded to *O. auricula* (Cke.) Massee but have a palisade arrangement of the excipular layer similar to what Massee (l.c.) reported for *O. neglecta.**

* Since this paper went to press the writer has, through the kindness of Sir Edward Salisbury, seen specimens of *O. auricula* and *O. neglecta* from Kew

His illustration shows the palisade layer to be composed of parallel chains, which is unlike the palisade in the American specimens of *O. auricula*. In view of the condition found in the American material, one wonders whether or not Massee's conclusions were an altogether correct interpretation. The spores as reported in the literature are given as large, 22–25 × 12–16 μ. The paraphyses are straight and filiform. In these respects our specimens conform to the European *O. auricula*. Boudier placed the fungus in *Wynnella*.

MATERIAL EXAMINED: G. B. Cummins, Echo Lake, Flathead Nat. Forest, Montana, July 23, 25, and 31, 1928; F. J. Hermann, Big Stone Bay, Emmet Co., Mich., June 13, 1936.

OTIDEA SMITHII Kanouse, Pap. Mich. Acad. Sci. Arts & Letters **24**: 28. 1939 (FIGS. 8, 9).

Apothecia solitary or cespitose, arising from a large solid foot-like base composed of mycelium intermixed with soil, elongate, ear-shaped, fragile when dry, split on one side, up to 8 cm. in height, outside of apothecium "Van Dyke brown," "Rood's brown" shading to "vinaceous" toward base, inside "wood brown," drying "vinaceous-buff"; hypothecium, composed of hyaline, loosely interwoven hyphae; excipular layer narrow, composed of small thick-walled, brown cells loosely and irregularly arranged, at the surface bunched in shallow piles formed from groupings of 3–5-celled chains, surface cells covered with small granules golden brown in color; asci cylindrical, 100–160 × 12–14 μ, 8-spored, not turning blue in iodine; spores hyaline or faintly colored yellowish, narrowly elliptical, smooth, biguttulate, 10–12 (14) × 6–7 μ; paraphyses with large hooked or bent apices, hooks sometimes ornamented by small, irregular protuberances.

HABITAT: On soil under conifers.

MATERIAL EXAMINED: E. G. Simmons, Lower Tahoma Creek, Wash., Sept. 5, 1948, *2180, 2182;* A. H. Smith, Crescent City, Calif., Nov. 18, 1937, *8843,* Dec. 3, 1937, *9340;* Lower Tahoma Creek, Wash., Sept. 28, 1948, *30994, 30995.*

Herbarium presumably those seen by Massee. The writer could find no appreciable difference in the specimens examined. They appeared to have a pallisade arrangement of the excipular cells. No specimens retained any appearance of white exteriors.

OTIDEA GRANDIS (Pers.) Rehm. 1887–1896. p. 1023. 1894 (FIGS. 11, 12).

Apothecia solitary or cespitose, 1–2 cm. high, 1–4 cm. broad, fleshy-leathery, drying horny, stipitate, truncate, expanded, split to base, edges of split and top of apothecium deeply enrolled when dry; outside "Van Dyke brown," "liver brown" mealy-scurfy, hymenium pale, "vinaceous fawn," "ochraceous tawny" (dry), frequently with patches of red-orange, the orange red color conspicuous when the cups are revived in water, stipe thick, up to 1 cm. long, yellowish in color; hypothecium composed of coarse, hyaline, septate hyphae, loosely interwoven; excipular layer sharply differentiated from the hypothecial layer, composed of thick-walled hyphal segments that resemble small subglobose or irregularly hexagonal cells, walls dark brown, 15–20 μ in diameter, outermost layer of excipular segments covered with minute granules which are subglobose, golden brown in color, becoming easily detached; outside drying mealy, rough; asci cylindrical, 185–200 × 10–12 μ, 8-spored, uniseriate, not turning blue in iodine, collapsing when empty, spores long elliptical to slightly fusoid, 14–17 × 6–7 μ, biguttulate, outer wall smooth, inner wall becoming minutely roughened in age, occasionally biseriate in upper part of asci; paraphyses filiform, frequently forked below, apices strongly hooked, sometimes clavate, 4–5 μ in diameter.

HABITAT: On the ground.

DISTRIBUTION: New York, Nova Scotia, Michigan, Europe.

DISCUSSION: Rehm remarked upon the lack of the green color in *O. grandis*. Boudier (**1905–1910**) and Bresadola (**1932**) both illustrate the species as having olive green shades in the exterior of the cups. Our North American collections as well as the European collection represented by Sydow, Mycotheca Germanica No. 2354 lack green color in the dry condition; they are uniformly liver brown. While no color notes are available on fresh material, it is doubtful whether or not any distinct olive green color was ever present in the outside of the apothecia. The hymenium (dry) is lighter in color but when soaked in water developed some shade of orange, frequently a bright orange-red. The apothecia in our material are all more shallow than indicated by Boudier's illustration. In microscopic characters, however, the specimens conform with Rehm's description of the species. The spores are long-elliptical and tend to be narrow at the ends.

The outer wall is smooth but in age the inner wall is minutely roughened. This character is apparent with the aid of an oil immersion lens. The granules on the excipular segments add to the intensity of the brown color of the outside of the apothecia. They are readily washed off in a water mount. Boudier (**1905–1910**) illustrated them for *O. umbrina,* but no other investigator seems to have observed them for they have not been mentioned elsewhere. They make a useful diagnostic character for these species.

MATERIAL EXAMINED: Ellis and Everhart, North American Fungi *1778,* second series, as *Peziza onotica* Pers.; Sydow, Mycotheca Germanica *2354;* C. H. Kauffman, Caroline, N. Y., Sept. 6, 1903; Lake Woods, Mich., Aug. 18, 1915; Morten Lange, Burt Lake, Cheboygan Co., Mich., Aug. 4, 1947; E. B. Mains, Deerton, Mich., Sept. 2, 1932, *32–517;* Rock River, Mich., Sept. 6, 1932, *32–609;* Emerson, Mich., Sept. 2, 1933, *33–580;* A. H. Smith, Salmon River, Nova Scotia, Aug. 18, 1931, det. L. E. Wehmeyer (*1344*) as *O. leporina;* Catlin Lake, N. Y., Aug. 19, 1934, *396;* Milford, Mich., July 29, 1937, *6687;* Maple River, Cheboygan Co., Mich., July 22, 1947, *25931.*

Otidea Kauffmanii sp. nov. (FIGS. 13, 14).

Apothecia solitaria usque gregaria, stipitata, 2–3 cm. alta, truncata, 2–4 cm. lata, rupta, "chamois" usque ochracea, sicco roseo-lutea; hymenio cremeo-luteo, sicco roseo-luteo; stipite 5–10 mm. alta, 3–5 mm. crassa; hypothecio prosenchymatico, excipulo pseudoparenchymatico, cellulis superficiei irregularibus; ascis 150–200 × 10–12 μ, sporis ellipticis, levibus, biguttulatis, 8–10 (12) × 5–6 (7) μ; paraphysibus hyalinis, saepe subtus ramosis, filiformibus, apicibus subito incrassato, globosis aut clavatis, 6–10 μ diam.

Ad humum, 18 Julii 1915, Lakeland, Michigan, C. H. Kauffman, **Typus.**

Apothecia solitary to gregarious, stipitate, 2–3 cm. in height, truncate, 2–4 cm. in width, split down the short side of the cup, fleshy, hard when dry, "chamois" to "ochraceous" (fresh), dirty pinkish buff (dry); hymenium "cream buff" (fresh), "pinkish buff" (dry), whitish pubescence on lower part of cup extending into the stipe; stipe 5–10 mm. long, 3–5 mm. thick; hypothecium composed of hyaline hyphae, densely interwoven, excipular layer 100–150 μ thick, pseudoparenchymatic, forming irregular piles of cells on the outer surface; asci cylindrical, 150–200 × 10–12 μ, base long, slender, sometimes twisted, 8-spored, not colored blue in iodine; spores elliptical, smooth, biguttulate, faintly colored yellowish, 8–10 (12) × 5–6 (7) μ; paraphyses flexuous, filiform, hyaline, septate, infrequently branched below, apices enlarged into broadly clavate, pyriform or globose heads 6–8 (10) μ diameter, frequently bent (never hooked).

HABITAT: On the ground.

DISTRIBUTION: Michigan.

DISCUSSION: Ample notes were made by Dr. Kauffman on the fresh material of the collection which has been designated as the type. The globose heads of the paraphyses were noted by him in the fresh material. They are also conspicuous in the dry specimens. Paraphyses of this type were also found in *Otidea rainierensis* which is described in this paper. However, the two species are distinct on the basis of size, shape and color of apothecia and also on differences in spore size.

MATERIAL EXAMINED: In low frondose woods, Lakeland, Michigan, July 18, 1915, collected by C. H. Kauffman, **type.** Reported by C. H. Kauffman, Report Michigan Academy of Science **9**: 146. 1917, as *Otidea phlebophora* (B. & Br.) Phillips; A. H. Smith and R. J. Porter (Smith *21147*), George Reserve, Pinckney, Mich., Oct. 6, 1945; A. H. Smith, Strawberry Lake, Mich., July 19, 1929.

Otidea rainierensis sp. nov. (FIGS. 15, 16).

Apothecia solitaria aut gregaria, ex basi stipitosa oriunda, 3–7 cm. alta, 3–5 cm. lata, in siccitate fragilia, extus ochraceo-lutea usque pallide brunnea, intus avellanea usque grisea; hypothecio prosenchymatico, excipulo pseudoparenchymatico, catenis brevibus cellularum praedito; sporis ellipticis, levibus, biguttulatis, 10–12 × 6–7 (8) μ; paraphysibus filiformibus, apicibus subito incrassatis, globosis aut subglobosis aut clavatis 6–8 (10) μ diam.

Ad humum sylvaticum. Lower Tahoma Creek, Mt. Rainier National Park, Washington, Aug. 23, 1948. A. H. Smith No. 30553, **Typus.**

Apothecia solitary to gregarious, arising from a short stalk-like base, 3–7 cm. in height, nearly as wide as high, substance thin and fragile when dry, split to the base, edges enrolled, exterior "ochraceous buff," "cinnamon buff" to "wood brown" (dry), inside "avellaneous," "vinaceous buff" to "drab gray" (dry), creamy white toward base, stipe up to 1 cm. in height, tending to be hollow; hypothecium composed of hyaline hyphae loosely interwoven, merging gradually into a shallow excipular layer 50–100 μ in thickness, exciple composed of large subglobose or elongated cells only faintly colored yellow, irregularly arranged, the outermost layer of which produces a few chains; asci cylindrical, 140–160 × 10 μ, frequently with a long slender stalk-like base, not turning blue in iodine; spores elliptical, smooth, faintly yellowish, biguttulate, 10–12 × 6–7 (8) μ, arranged obliquely in the asci; paraphyses hyaline, septate, very slender, filiform, abruptly thickened at the apices into broadly clavate, pyriform, subglobose to globose heads 6–8 (10) μ in diameter.

HABITAT: On humus in woods.

DISTRIBUTION: Washington.

MATERIAL EXAMINED: Lower Tahoma Creek, Mt. Rainier National Park, Wash., Aug. 23, 1948, A. H. Smith *30553*, **type**; A. H. Smith, Aug. 22, and Aug. 23, 1948, *30443*, *30556*; E. G. Simmons, Sept. 5, 1948, *2179*.

OTIDEA ABIETINA (Pers. ex Fr.) Fuck. Symb. Myc. 330. 1869–1870 (FIGS. 17, 18).

Apothecia solitary or gregarious, short stipitate, 2–4 cm. broad, 2–3 cm. in height, usually split on one side, truncate, "liver brown" outside, concolorous within, stipe short, arising from a mass of debris bound together with mycelium, whitish tomentose at base; hypothecium composed of coarse hyphae loosely interwoven, excipular layer consisting of large, thick-walled cells hexagonal in shape, the outermost layer of cells smaller in size, and forming a nearly even surface with but few protruding chains of cells; asci cylindrical, 200–250 × 12–15 μ, 8-spored, not colored blue in iodine; spores elliptical, smooth, faintly colored yellowish, biguttulate, 18–20 (22) × 10–12 μ; paraphyses filiform, forked below, septate, apices bent, enlarged and variously ornamented with proliferations and notches or branches usually on the under side of the bent portion, filled with granules faintly colored yellowish, extending beyond the asci forming a loose tangle.

HABITAT: On ground.

DISCUSSION: *Peziza abietina* Pers. was transferred to the genus *Otidea* by Fuckel. It has since been placed in *Aleuria* by Gillet (**1879**), in *Discina* by Rehm (**1887–1896**). Boudier placed it in his genus *Pseudotis*, Bresadola (**1932**) in *Otidea*, and Seaver (**1928**) in *Peziza*. These interpretations are indicative of the uncertainty regarding the generic position of the species. The fact that apothecia are sometimes without a split is probably the reason for its being assigned to genera other than *Otidea*. However, there is sufficient proof that the split condition is the more common, and thus it is logical to seek for the species in the genus *Otidea*; therefore a description is included here. That there is no blue coloration in iodine, that the paraphyses are bent, and that the spores are biguttulate, suggest its affinity with species of *Otidea*. It is certain that one would expect to find it listed in *Otidea* whenever cups with true splits were found and the bent paraphyses

would also suggest this relationship. The under side of the bend in the paraphyses is ornamented with notches and short proliferations which give them a distinctive appearance. It is not uncommon to find similar modification in paraphyses in other *Otidea* species but never has the author seen them so profuse or so conspicuous. The paraphyses project beyond the asci and form loose tangles but are not organized into a definite epithecial layer. Boudier (**1905–1910**) and Bresadola (**1932**) illustrate them, but the latter's figures show fewer proliferations. The spore size according to most authors is reported as large (18–20–26 × 10–12 μ). Rehm points out that the specimen cited by Fuckel (No. 1226) which he himself examined is *Peziza badia;* that the spores measured only 14 × 7 μ, and are rough. The notched paraphyses, the lack of blue coloration and split apothecia were constant in the collections cited in this study.

MATERIAL EXAMINED: Sydow: Mycotheca Germanica *2540* (*Discina abietina* (Pers.) Rehm). G. B. Cummins, Echo Lake, Montana, July 6, 1928; C. H. Kauffman, Ithaca, N. Y., Aug. 6, 1904; C. H. Kauffman and D. V. Baxter, Tolland, Colo., Sept. 1920; E. B. Mains, Rock River, Mich., Aug. 20, 1932, *32-179;* A. H. Smith, Lake Quinault, Wash., May 17, 1939, *13566*; Lake Crescent, Wash., Oct. 28, 1935.

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EXPLANATION OF FIGURES

FIG. 1. Paraphyses of *Otidea leporina* var. *typica;* FIG. 2. Spores of *Otidea leporina* var. *typica;* FIG. 3. Paraphyses of *Otidea alutacea* var. *typica;* FIG. 4. Spores of *Otidea alutacea* var. *typica;* FIG. 5. Straight, filiform paraphyses of *Otidea auricula;* FIG. 6. Spore of *Otidea auricula;* FIG. 7. *Otidea auricula;* a fascicle of elongate cells such as form the outermost layer of exciple; FIG. 8. Paraphyses of *Otidea Smithii;* FIG. 9. Spores of *Otidea Smithii;* FIG. 10. Detail showing a branched chain of cells in the exciple of *Otidea onotica;* FIG. 11. Paraphyses of *Otidea grandis;* FIG. 12. Spores of *Otidea grandis;* FIG. 13. Paraphyses of *Otidea Kauffmanii,* showing the abruptly clavate and globose apices; FIG. 14. Spores of *Otidea Kauffmanii;* FIG. 15. Paraphyses of *Otidea rainierensis* showing the clavate to globose apices; FIG. 16. Spores of *Otidea rainierensis;* FIG. 17. Paraphyses of *Otidea abietina* showing the protuberances frequently found; FIG. 18. Spores of *Otidea abietina.*

A NEW SPECIES OF ACHLYA WITH COILED OOGONIAL STALKS [1]

T. W. JOHNSON, JR.[2]

(WITH 2 FIGURES)

In the course of recent studies on the genus *Aplanes*, a considerable number of soil and water samples have been collected from various localities in Michigan. From two of these collections, made in Washtenaw County, a species of *Achlya* has been recovered which differs markedly from any of the hitherto described species of the genus.

Following recovery from the soil, a single-spore isolate was grown on cornmeal agar, then transferred to boiled, split hempseed, placed in 30 cubic centimeters of sterile, charcoal-filtered, distilled water, and kept at a temperature of 22° C. The description of the species was compiled from such cultures. An examination of the isolate revealed that whereas it resembled, in certain general features, several of the papillate species of *Achlya*, it was actually quite distinct from them. These distinctions are found in the characteristic coiled, spring-like oogonial stalks, the large oospores, the variously-shaped oogonia, and in the sparseness of antheridia. For these reasons, it is considered a new species.

Achlya spiracaulis sp. nov. Myceliis in semine *Cannabis sativae* tenuibus, hyphis ramosis porrectis usque ad 3.0–4.2 cm. in diametrum. Gemmis paucis longis quandoque inaequalibus; sporangiis copiosis, attenuatis sine cylindraciis ad basim saepius latioribus, 280–637 μ longis, 28–42 μ in diametrum, plerumque 497–595 × 35–42 μ, e basi proliferantibus et tunc cymosis; zoosporiis 11.0–14.1 μ in diametrum, apice dehiscentibus et in sphaerula dispositis, perraro *in situ* germinantibus. Oogoniis copiosis in ramulis lateralibus longis et spiriformibus aut raro brevibus et rectis, nonnumquam terminalibus in summo hyphae spiriformis, saepius autem. Oogoniis ipsis

[1] Contribution No. 897 from the Department of Botany, University of Michigan.

[2] The author wishes to express his sincere gratitude to Professor F. K. Sparrow for his helpful suggestions and criticisms in the preparation of this paper.

44.0–83.6 μ in diametrum sine spinis, plerumque 60.6–72.5 μ, aut globosis aut variis, tunica crassa non-punctulata, consista spinis sublongis obtusis. Oosporiis numero 1–12, plerumque 4–8, globosis 13.2–49.5 μ in diametrum, plerumque 25.0–30.8 μ, guttulis oleosis centrice dispositis; tunica crassa, hyalini. Antheridiis paucis diclinibus aut androgenibus.

Hab: ad terram humosam in ripa rivi intermittentis, Nichols' Arboretum, University of Michigan, Aprilis 4, 1949.

Mycelial growth tenuous, extensive, the colony reaching a diameter of 3.0–4.2 cm. on hempseed; principal hyphae up to 119 μ in diameter at the base; usually sinuous, moderately branched. Gemmae few, single, terminal, long-tapering and sporangium-like; occasionally quite irregular; upon germination forming thin hyphal branches usually bearing small apical sporangia; rarely germinating to form a terminal oogonium. Sporangia abundant, terminal, long-tapering or cylindrical, usually broadest at the middle or near the base, 280–637 μ long by 28–42 μ in diameter, predominantly 497–595 × 35–42 μ; secondary sporangia arising by cymose branching or in basipetal succession from below the primary sporangia, in which case including basally a portion of the hypha. Spores at discharge collecting in a hollow sphere at the apical pore, or germinating *in situ* in some secondary sporangia; encysted spores 11.0–14.1 μ in diameter. Oogonia abundant, borne laterally on very long, tightly or loosely coiled and bent stalks, rarely on short, straight or bent stalks; stalks sometimes branched, and bearing 2–3 oogonia; infrequently terminal, with the hyphal branch also coiled; never observed intercalary; varying greatly in shape, mostly spherical or ovoid, occasionally barrel-shaped, oblong or irregular; wall averaging 1.2 μ thick, unpitted, densely studded with short or long, round-pointed spines 4.4–30.8 μ in length, averaging 9.9–14.3 μ; oogonia, not including spines, 44.0–83.6 μ, averaging 60.6–72.5 μ in diameter; irregular oogonia averaging 104 × 51 μ. Oospores 1–12, mostly 4–8; 13.2–49.5 μ, averaging 25.0–30.8 μ in diameter; centric, with a single layer of oil droplets completely surrounding the protoplasm; typically spherical, but occasionally block-shaped or ellipsoidal from pressure; wall thick, hyaline. Antheridial branches present on 8–12 per cent of the oogonia, about equally androgynous and diclinous; antheridia applied by their apices to the oogonia; antheridial cells rarely formed; fertilization tubes not observed.

From soil, along bank of an intermittent stream, Nichols' Arboretum, University of Michigan, April 4, 1949 (**type**), and from soil, along bank of Fleming Creek, near Geddes Road, Washtenaw County, Michigan, May 8, 1949.

FIG. 1. *Achlya spiracaulis.*

Slides of preserved material from the type culture are being deposited in the herbaria of the University of Michigan and the University of Illinois.

Achlya spiracaulis has been compared with the original descriptions of all known species of *Achlya*, and although it embodies characteristics of several of these, it differs from them in one outstanding respect: *i.e.*, the production, even under varying environmental conditions, of coiled oogonial stalks. In this feature, the fungus resembles *Achlya contorta* Cornu, but from Cornu's incomplete description and meager illustrations (**8**), his species possesses smooth-walled oogonia. On the basis of oospore number, and unpitted, spiny oogonial wall, there is a resemblance to *Achlya papillosa* Humphrey (**10**). However, the sparingly developed sporangia, short oogonial stalks, and the abundant though imperfectly formed antheridia immediately separate *A. papillosa* from the present species.

Coker (**3**) reports coiling oogonial stalks for *Achlya proliferoides* (**3**, pl. 36, *fig. 6*), but because of its smooth oogonial walls, short oogonial stalks, and abundant antheridia, his species is obviously not the Michigan isolate. Coiled oogonial stalks were also reported by Coker (**3**) for *Achlya Orion*, but these were formed only at a temperature of 36° C. Further, the smooth-walled oogonia and the smaller number of larger oospores also distinguish *A. Orion* from *A. spiracaulis*.

The original description of *Achlya recurva* by Cornu (**8**) is rather vague. A more complete study was made by Latham (**11**) of an isolate of *A. recurva* found in North Carolina. *Achlya spiracaulis* evidently resembles Latham's fungus in certain respects, particularly with reference to the atypical, contorted oogonia, the size of encysted zoospores, oospore number, and the scarcity of gemmae. However, because of the coiled oogonial stalks, larger oogonia, larger oospores, and smaller percentage of antheridia, *A. spiracaulis* is distinct from *A. recurva*.

With the exception of *Achlya contorta*, coiled oogonial stalks are not reported for any of the European species of *Achlya*. In addition, other characteristics of these species, such as oospore size and number, size of oogonia, and antheridial characteristics, differentiate them from *A. spiracaulis*.

OBSERVATIONS

It would be repetitious to record details of sporangial formation and subsequent development and discharge of the zoospores, since, with the possible exception of basipetalous development of secondary sporangia (FIG. 1, D) in older cultures, and germination *in situ* in many of these secondary sporangia (FIG. 1, E), the developmental morphology of the sporangia is that characteristic of the genus *Achlya* (**12**). Certain points concerning oogonial development in *A. spiracaulis* should, however, be mentioned. As observed in young cultures in sterile, charcoal-filtered, distilled water, the oogonium first appears as a short, lateral protrusion from the main hypha (FIG. 1, L). Over a three or four day period following the appearance of the protrusion, there is a marked elongation into a definite lateral stalk, which, after about three days, begins the characteristic coiling (FIG. 1, M, N). Branching of the oogonial stalk may occur prior to or immediately after coiling (FIG. 1, K). Upon completion of coiling, the tip of each stalk enlarges, and one to several spine-like protrusions make their appearance, which give to the oogonial initial a distinct irregular shape (FIG. 1, O). The tip continues to enlarge, the spines become more numerous, and ultimately the oogonium reaches mature size. It is at about this time that antheridia, if any, are formed. The development of oospores is slow, even in oogonia which are apparently fertilized, since in most cases no oospores are visible for six to eight days after the oogonia reach mature size. Where oogonia are formed terminally, the first indication of their development is again coiling of the stalk, in this instance, the hyphal tip. The subsequent development of terminal oogonia is similar to those formed laterally.

In fifteen- to twenty-day-old cultures, there are occasional instances of oogonia borne on bent or once-coiled stalks (FIG. 2, G, J). Many of the later-formed stalks do not bear oogonia, and in still older cultures may give the hyphae a distinctive, short-branched, bushy or irregular appearance (FIG. 1, P).

Preliminary qualitative studies on the effect of variations in environments other than pure water on *Achlya spiracaulis* have been undertaken. Results would seem to indicate that the distinguishing

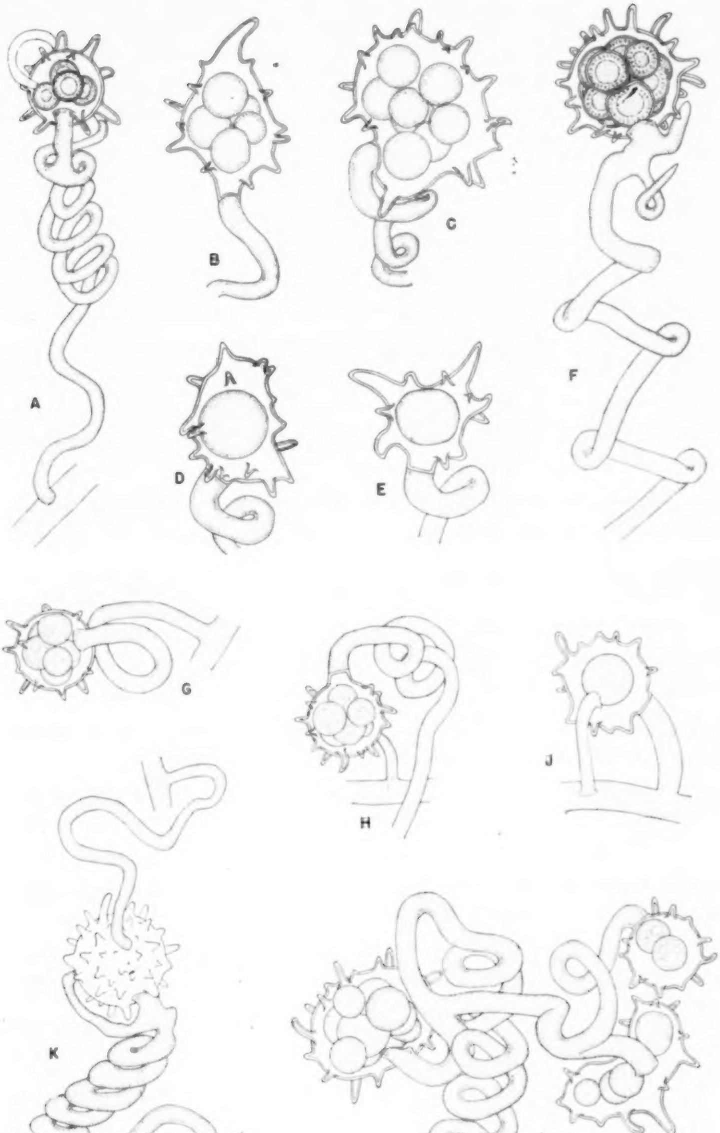

FIG. 2. *Achlya spiracaulis.*

coiled-stalk characteristic of the fungus, as well as such features as origin and size of the oogonia, papillations of the oogonial wall, and percentage of antheridia, are consistently stable characteristics.

To determine the characteristics of the fungus when grown in a more natural habitat, a series of 20 single spore isolates were grown in 20 separate samples of water containing leaves and other debris. The water and debris samples were selected from several different sources such as fresh cold water, stagnant cold water, and warm, clear, running water. After the colonies had developed for two weeks in these "natural" habitats, they were observed for possible changes in morphology. In all of these cultures, the fungus retained the characteristics as described. Of interest, nevertheless, is the fact that the appearance of oospores in these cultures was remarkably slow, in most cases not occurring for two to three weeks after the formation of the oogonia.

A more complete study of the effect of varied environments on the morphology of the fungus is to be undertaken at a future date.

SUMMARY

A new species of *Achlya*, from Michigan, is described as *Achlya spiracaulis*. The fungus is characterized by long, tightly or loosely coiled oogonial stalks, by which it is easily distinguished from all other species of *Achlya;* large, papillate, spherical to irregular oogonia; large, centric oospores; unpitted oogonial walls, and a low percentage of about equally diclinous and androgynous antheridia.

The fungus was grown under several varied environmental conditions (including those simulating natural ones), to induce changes in the distinguishing morphological characteristics, but the results of these preliminary studies show that the coiled oogonial stalks, origin of oogonia, and frequency and type of papillations are consistently stable.

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DESCRIPTION OF FIGURES

Achlya spiracaulis. FIG. 1, *A*. Habit of sporangia, showing cymose branching. *B*. Undischarged sporangium. *C*. Discharged sporangium. *D*. Habit, showing basipetalous development of secondary sporangia. *E*. Secondary sporangium with spores germinating *in situ*. *F, G, H*. Typical gemmae. *J*. Gemma which has germinated to form a small oogonium at its apex. *K*. Young oogonial stalk which shows branching prior to coiling. *L, M, N, O*. Stages in the development of the oogonial stalk, and rudiment of the oogonium. *P*. Cluster of undeveloped oogonial stalks in a thirty-day-old culture. All drawings made with aid of Spencer camera lucida. Figs. *A, D, F, G, H, J*, and *P*, × 170; all others, × 410.

FIG. 2, *A*. Typical spherical oogonium with long, coiled, lateral stalk, androgynous antheridium, and mature oospores. *B, C, D, E*. Irregular, contorted oogonia with immature oospores. *F*. Terminal, spherical oogonium showing loose-coiling of hypha, mature oospores, and an undeveloped antheridium. *G*. Spherical oogonium with once-coiled, lateral stalk. *H*. Spherical oogonium with diclinous antheridium and short-coiled stalk. *J*. Spherical oogonium with androgynous antheridium and short, bent, lateral stalk. *K*. Spherical oogonium showing tightly-coiled lateral stalk, papillations of oogonial wall, and both a diclinous and an androgynous antheridium. *L*. Coiled, branched, lateral oogonial stalk with one spherical, one oval, and one constricted oogonium, all with immature oospores. All figures × 840.

STUDIES ON SOME UNUSUAL HETERO-BASIDIOMYCETES FROM WASHINGTON STATE [1]

George Nyland [2]

(with 6 figures)

In a previous paper (**6**) the morphology and cytology of an undescribed Heterobasidiomycete was discussed. It was noted that, although the fungus had a spore stage indistinguishable from *Sporobolomyces*, it could not be placed in that genus because of the presence of mycelium with numerous clamp connections and with abundant, thick-walled, brown chlamydospores.

This paper describes in more detail the characteristics of the fungus and, to accommodate it, a new genus and species, *Sporidiobolus Johnsonii*, is proposed. A previously undescribed species of a closely related genus, *Itersonilia* Derx, is also described.

Sporidiobolus gen. nov.

Ballistosporae in sterigmatibus formatae et per vim effusae. Sterigmata aetheria e mycelio aut statim e ballistosporis ascendentia. Ballistosporae ad propagationem multiplicatione sporarum aut ad gemmandum eodem modo fermenti aptae. Mycelium hyalinum septatum cum conjunctionibus. Chlamydosporae spisse circumdatae et fuscae, terminales aut intercalares.

Species typica: *Sporidiobolus Johnsonii.*

Ballistospores produced on tips of sterigmata of variable length and forcibly abjected by drop-excretion mechanism. Sterigmata arising as branches from mycelium or directly from ballistospores. Ballistospores capable of reproduction by repeating spores or by budding in yeast-like manner. Mycelium septate with clamp connections. Chlamydospores terminal or intercalary, brown, thick-walled, produced on mycelium.

[1] A condensed portion of a thesis presented to the Faculty, State College of Washington, May, 1948, in partial fulfillment of the requirements for the degree of Doctor of Philosophy. Published as Scientific Paper No. *844*, Agricultural Experiment Stations, Institute of Agricultural Sciences, State College of Washington, Pullman, Washington.

[2] Junior Plant Pathologist and Instructor, University of California, Davis, California.

Sporidiobolus Johnsonii spec. nov.[3]

Ballistosporae 6–13 × 3.5–6.5 μ (sporae circa 9 × 5 μ sunt), hyalinae, quae per saturam puniceae, leve flexae, incongruentes, reniformiatae-lunatae sunt, quae propagatione crescendarum sporarum aut cellis quae eodem modo fermenti gemmant, quae aut in re gemmandis perseverare aut ballistosporas parere possunt, germinant. Ballistosporae e mycelio parere etiam possunt. Mycelium linea media 1.5–3 μ septatum, copiosis cum conjunctionibus. Chlamydosporae maturitate fulvae, linea media 10–16 μ, in brevibus hyphis formatae, terminales aut intercalares, cum conjunctione in caule in cuiusque sporae radice.

Hab. In soro *Phragmidii rubi-idaei* (DC.) Karst. in foliis *Rubi idaei* L. Puyallup, Washington, U. S. A.

Ballistospores 6–13 × 3.5–6.5 μ (ave. 9 × 5 μ), hyaline by transmitted light, salmon pink in mass, slightly curved, asymmetrical, reniform-lunate; germinating by forming sterigmata and repeating ballistospores, or by budding vegetative, yeast-like cells which in turn may continue to bud or may produce ballistospores. Ballistospores may also be produced from the mycelium on short sterigmata. Colony on malt agar appressed, hyphae 1.5–3 μ diameter, septate, with clamp connection at almost every septum. Chlamydospores hyaline when young, golden brown when mature, 10–16 μ diameter (ave. 12 μ), wall 1–1.5 μ thick, contents oily, formed on hyphae in or on surface of matrix, usually on short lateral stalks, terminal or intercalary, with a clamp connection on each stalk at base of spore, often with a hyaline hyphal projection from distal end of chlamydospore.

Habitat: In pustule of *Phragmidium rubi-idaei* (DC.) Karst. on living leaf of *Rubus idaeus* L. vicinity of Puyallup, Washington, summer 1946.[4]

This species differs from species of *Sporobolomyces* only by its production of a well developed mycelium and chlamydospores. The budding, vegetative cells and the ballistospores are indistinguishable from those occurring in species of *Sporobolomyces*.

During the course of this work several other fungi resembling *Sporidiobolus* were isolated and one of these is described below as a new species in the genus *Itersonilia* Derx.

The genus *Itersonilia* was proposed by Derx (3) in May, 1948, to accommodate a fungus isolated by him for the first time in 1925. He obtained the fungus by attaching a leaf of *Althaea rosea* bearing

[3] Type specimen deposited in the Mycological Herbarium, State College of Washington, Pullman, Washington.

[4] Isolated by Dr. Folke Johnson and named in his honor.

numerous sori of *Puccinia malvacearum* Mont. to the lid of a petri dish. Of the many basidiospores of the rust that were projected downward onto the agar, he observed that the majority showed only the beginnings of a germination which ended with a sketchy secondary spore. But among the number some produced a true mycelium equipped with numerous clamp connections. From the mycelium there developed sparse aerial hyphae, and from these were produced long, tapering sterigmata on which were produced spores having the characteristic form of basidiospores. These were projected at maturity and continued the same cycle of development. The spores of this fungus were nearly the same size as those of *Puccinia malvacearum* so unless permitted to grow could not easily be distinguished from them. Derx (**3**) figures enlarged swollen cells with thin cell walls, each provided with a clamp at its base, on the mycelium of *Itersonilia*. He aptly calls his new species *I. perplexans*. Because his descriptions occur in a somewhat obscure journal they are repeated here for convenience (**3**).

"*Itersonilia* Derx *gen. nov.*

"Mycelium hyalinum, septatum, repens, fibuligerum ut typice in Basidiomycetibus; inflationibus terminalibus denique post excrescentionem terminalem saepe intercalaribus; sporophoris in aera ascendentibus, non-ramosis, apicem versus sensim attenuatis, in sterigma exeuntibus. Sporae solitariae, terminales, asymmetricae, uno latere plus minusve depressae, crassiusculae, non-falcatae, leves, hyalinae.

"Species typica: *Itersonilia perplexans* Derx *spec. nov.*

"*Itersonilia perplexans* Derx *spec. nov.*

"Mycelium 3–5 μ diam., in septis omnibus fibuligerum; inflationibus lato-ellipsoides vel obovoideis, 12–16 $\times$ 9–10 μ, hyalinis. Sporae subreniformes vel ovoideae, leves, tenuiter tunicatae, 14–15 μ $\times$ 8–10 μ—In foliis *Althaeae roseae* intra soros *Pucciniae malvacearum*."

The term "ballistospore" has been used by Derx (**3**) at the suggestion of Dr. M. A. Donk to include those spores of the Basidiomycetes that are forcibly abjected at maturity by the drop-excretion mechanism studied by Buller (**1**). The general term seems appropriate, especially for the Sporobolomycetaceae and related forms, since it has not been established that the ballistospores in these fungi are actually basidiospores.

A species of *Itersonilia* was obtained by the writer, using essentially the same technique as Derx, from a dead leaf of *Acer macrophyllum* Pursh, in February, 1948. It is considered to dif-

fer sufficiently from *I. perplexans* to warrant the erection of a new species.

Itersonilia pyriformis spec. nov.[5]

Ballistosporae incongruentes, reniformatae-lunatae, 11.7–19.5 × 6.5–9.1 μ (sporae circa 15.6 × 7.3 μ sunt) in sterigmatibus e mycelio aut multiplicatione formatae. Hyphae aetheriae, copiosae, candidae linea media 2.4–2.6 μ, hyphae hyalinae submergitae linea media 1.2–1.5 μ ambae septatae cum in prope quoque septo conjunctionibus. Chlamydosporae in matrice hypharum, hyalinae, subtile circumdatae, aut pyriformatae aut globosae aut ovatae, sporae circa 16 × 7.8 μ sunt.

Hab. In foliis morto *Aceris macrophylli* Pursh.

Ballistospores asymetrical, reniform-lunate, 11.7–19.5 × 6.5–9.1 μ (average 15.6 × 7.3 μ), formed on sterigmata from the mycelium, or by repetition, but not budding in yeast-like manner. Mycelium on malt agar white, aerial, surface hyphae, 2.4–2.6 μ diameter, submerged hyphae hyaline, 1.2–1.5 μ diameter, septate, with clamp connections on almost every septum. Chlamydospores formed on hyphae in matrix, hyaline, thin-walled, pyriform to globose or oval, usually intercalary, average 16 × 7.8 μ.

Habitat: Dead leaf of *Acer macrophyllum* Pursh, collected near Kent, Washington, U. S. A., February 26, 1948, by G. W. Fischer.

This species differs from *Itersonilia perplexans* in that the chlamydospores have no clamp connections associated with them and by the presence of abundant aerial mycelium on malt agar. Also the ballistospores of *I. pyriformis* are somewhat shorter than those of *I. perplexans.* The genus *Itersonilia* differs from *Sporidiobolus* in several ways. In *Sporidiobolus* the ballistospores may bud in a yeast-like manner but in *Itersonilia* they germinate directly to form a mycelium or occasionally form spores by repetition. The chlamydospores in *Sporidiobolus* are brown with thick walls whereas in *Itersonilia* they are hyaline with thin walls.

LIFE HISTORIES, PHYSIOLOGY, AND CYTOLOGY

I. SPORIDIOBOLUS JOHNSONII

Life History. The life history of *Sporidiobolus Johnsonii* has been described in a previous paper (**6**). A brief statement was

[5] Type specimen deposited in the Mycological herbarium, State College of Washington, Pullman, Washington.

made regarding germination of the chlamydospores after incubation at 35° C. for 6 days. Actually 12 to 14 days were required because the cultures were removed for 24 hours on alternate days. During the course of the sampling, numerous hyaline chlamydospores were observed to germinate directly by producing germ tubes that developed into a mycelium. These were judged to be young, hyaline chlamydospores and not rounded up ballistospores or vegetative budded cells because in most cases fragments of the mycelium could be observed attached to the spores.

When dilution transfers were made from old cultures, two types of colonies regularly resulted. The original mucous type formed

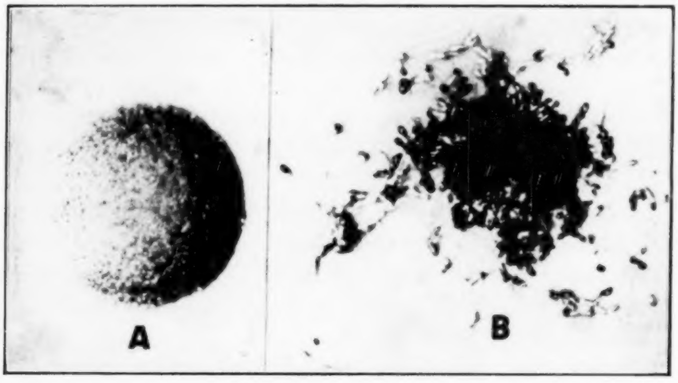

FIG. 1. *Sporidiobolus Johnsonii.* A, mucous and B, non-mucous type colonies. Note ballistospores on sterigmata in B. Approx. × 200.

as a result of budding and a non-mucous type formed as the result of the production of long sterigmata and pseudomycelium consisting of elongated, vegetative, budded cells. Both types of colonies were formed from either vegetative, budded cells or from ballistospores. This phenomenon was also reported as occurring in *Sporobolomyces* by Derx (**2**). The appearance of the two types of colonies is shown (FIG. 1). The non-mucous type of colony was more abundant if transfers were made from the oldest portion of the culture.

Longevity of this species in culture exceeded 18 months after which sampling was discontinued. Viable ballistospores were pres-

ent as long as the cultures were not completely desiccated, after which time the new growth seemed to arise only from the mycelium. Both ballistospores and new mycelium were produced in every case.

Temperature Requirements. To determine cardinal temperatures, 250 cc. Erlenmeyer flasks containing 35 cc. of 2 per cent Difco potato dextrose agar were inoculated in quadruplicate with 6 mm. disks of agar inoculum containing mycelium and resting spores. Inoculum was prepared on potato dextrose agar in Petri dishes and after thirteen days disks were cut out from the margins

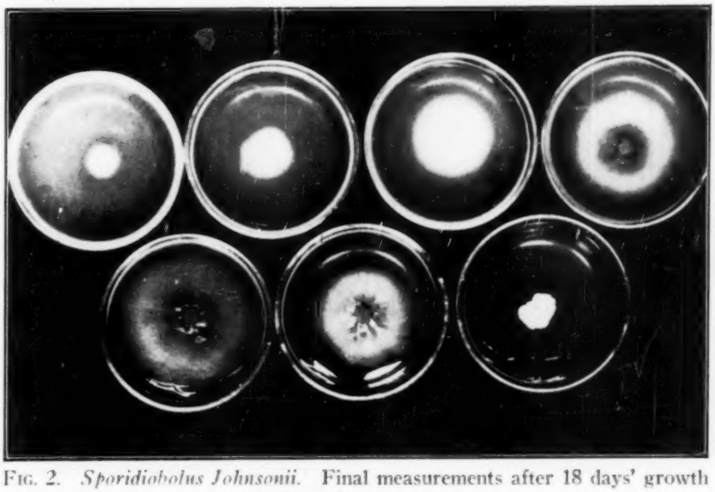

FIG. 2. *Sporidiobolus Johnsonii.* Final measurements after 18 days' growth at indicated temperatures.

of the colonies with a 6 mm. cork borer. Inoculum disks were transferred to the surface of the agar in the flasks with a flat-pointed needle. The flasks were placed in a constant temperature incubator at 26° C. for 17 hours prior to being incubated at the various temperatures, 5°, 10°, 15°, 20°, 25°, 30°, and 35° C. Measurements were made on the 5th, 9th, 13th and 18th days after incubation was begun. Cultures incubated at the optimum temperature (25° C.) completely covered the surface by the 18th day. The results are shown graphically (FIG. 2). Maximum growth of 80 mm. resulted at the optimum temperature of 25° C. Minimum

temperature for growth was approximately 5° C. and maximum temperature at which normal growth could take place was approximately 30° C. Some abnormal growth occurred at 35° C.

At 5° C. there was very little growth, the mycelium was profusely branched, very much appressed, and appeared somewhat mucose. Neither chlamydospores nor ballistospores were observed. At

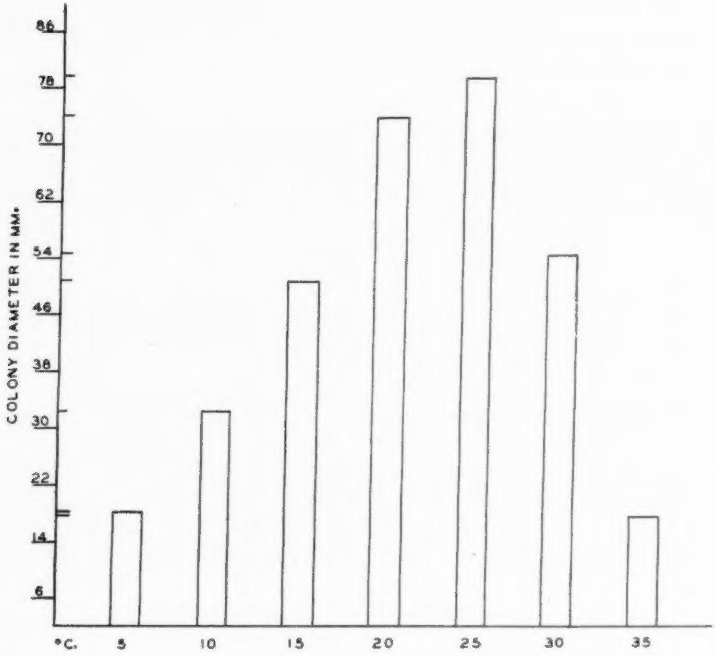

FIG. 3. *Sporidiobolus Johnsonii.* Reaction to various temperatures. Left to right, 5°, 10°, 15°, 20°, 25° (optimum), 30°, 35° C.

10° C. the colony appearance was much the same as at 5° C. but of somewhat greater diameter. Masses of chlamydospores were formed in the normal way but all were hyaline. At 15° C. there was a slight darkening or browning around the inoculum disk due to the brown walls of numerous chlamydospores. At 20° C. brown-walled chlamydospores were formed out from the center of the colony over about half the radius. A few ballistospores were

observed on sterigmata formed on the mycelium on the surface of the colony. At 25° C., the optimum temperature, chlamydospores were observed out to the very margin of the colony and even the margin had a brownish cast indicating rapid pigmentation of the spores after formation. Numerous ballistospores were observed. At 30° C. the margin of the brown, central area was irregular with dark streaks (chlamydospores) extending out almost to the margin of the colony. Some ballistospores were observed. At 35° C. the colony consisted entirely of ballistospores and budded vegetative cells formed in a pinkish, crusty mass. Examination under the microscope revealed that the ballistospores and vegetative cells were germinating to form secondary spores on long sterigmata in addition to budding. No true mycelium or chlamydospores were observed beyond the margin of the inoculum disk. These temperature reactions are illustrated graphically (FIG. 3).

Nutrient Requirements. The comparative rate and type of growth of *Sporidiobolus Johnsonii* was studied on eight agar media, as follows:

1. CD, Czapek's[6] with dextrose, 30 gms./liter
2. CS, Czapek's with sucrose, 30 gms./liter
3. CDP, Czapek's with dextrose plus peptone, 5 gms./liter
4. CSP, Czapek's with sucrose plus peptone, 5 gms./liter
5. C, Cornmeal agar (Difco)
6. P, Prune agar (Difco)
7. PD, Potato dextrose agar (Difco)
8. M, Malt agar (Difco)

Each agar medium was used in quadruplicate in 250 cc. Erlenmeyer flasks containing 25 cc. of medium. All were allowed to age two weeks before inoculation with 6 mm. agar blocks containing mycelium and chlamydospores. It was found that if the agar was allowed to age and dry out, somewhat more uniform mycelial growth resulted. Also aged agar inhibited the excessive formation of masses of vegetative budded cells and ballistospores. The 32 flasks were incubated at 25–26° C. for 15 days and colony measurements taken every other day. The results are presented graphically (FIG. 4). The organism grew most rapidly on malt agar

[6] Basic formula for Czapek's agar: $MgSO_4$ .5 gm., KH_2PO_4 1.0 gm., KCl .5 gm., $FeSO_4$ tr., $NaNO_3$ 2.0 gm., agar 25.0 gm., distilled H_2O 1000 ml., and dextrose, sucrose, and peptone as indicated.

and most slowly on Czapek's with sucrose plus peptone. It apparently utilizes dextrose more efficiently than sucrose for mycelial growth as shown by the difference of 8 mm. in average diameter of the colonies. Dextrose seems to be responsible for the lavish production of budded cells and ballistospores which occurred on Czapek's with dextrose, since this does not occur on Czapek's with sucrose. Peptone also seems to stimulate vegetative budding

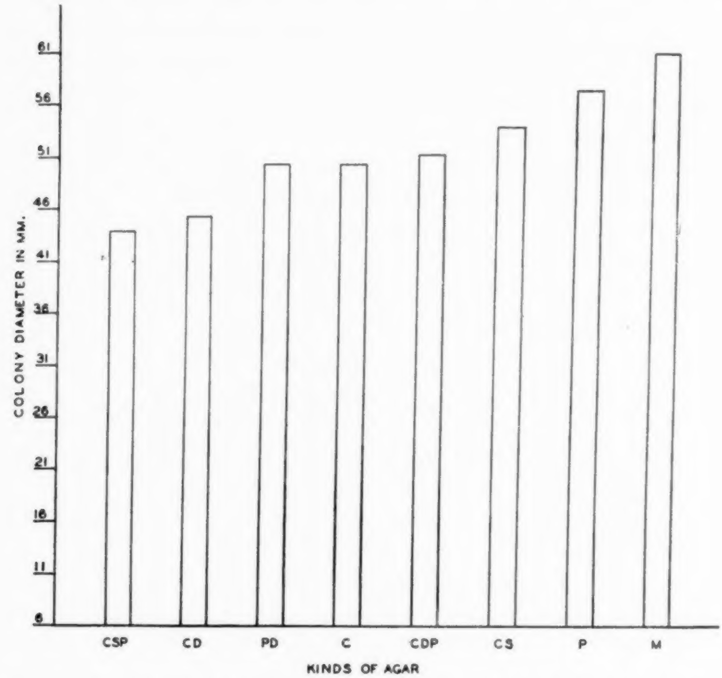

FIG. 4. *Sporidiobolus Johnsonii.* Colony diameter after 15 days' growth on 8 different media.

but to a lesser degree than dextrose. Czapek's with dextrose plus peptone resulted in larger colonies than Czapek's with dextrose alone. Czapek's with sucrose plus peptone, however, resulted in smaller colonies than Czapek's with sucrose alone. In Czapek's agar peptone, apparently, has a depressing effect on growth when associated with sucrose but a stimulatory effect when associated with dextrose, as contrasted to Czapek's with dextrose or sucrose

alone. Figure 5 shows the appearance of the colonies on the various media.

CYTOLOGY. It was shown that the ballistospores and the vegetative yeast-like cells of *Sporidiobolus Johnsonii* are uninucleate. Occasionally binucleate ballistospores were observed (**6**).

Because of the resemblance of this species to species of *Sporobolomyces*, it was considered advisable to examine as many species of *Sporobolomyces* as possible, cytologically and morphologically. The following available species [7] were studied:

Sporobolomyces alborubescens Derx, *S. gracilis* Derx, *S. odorus* Derx, *S. pararoseus* Olsen and Hammar, *S. roseus* Kluyver and van Niel, *S. pollaccii* Vernona and Ciferri, *S. rubicundulus* (Okunuki) Verona and Ciferri, *S. salmoneus* Derx, *S. salmonicolor* Kluyver and van Niel, *S. salmonicolor* var. *polymyxa* Kluyver and van Niel, *S. shibatanus* (Okunuki) Verona and Ciferri, *S. tenuis* Kluyver and van Niel (species strain Lederer), *Bullera alba* (Hanna) Derx (= *Sporobolomyces albus* Hanna).

All of the above species were observed to have uninucleate vegetative cells and ballistospores, thus confirming the observations of Guilliermond (**4**) and Buller (**1**) who studied several of the species.

To obtain mycelium and chlamydospores of *Sporidiobolus Johnsonii* satisfactory for cytological study small blocks of agar were taken from the margins of actively growing colonies on malt agar and transferred to slides containing Mayer's adhesive. The slides were then placed in Petri plates on moist filter paper. Hyphae grew out from the blocks of agar onto the slides and formed resting spores there. After five to ten days the material was killed and fixed by exposing it to fumes of osmic acid in Fleming's weaker killing fluid. The preparations were then permitted to air-dry thoroughly. After drying, a sharp scalpel was used to sever the hyphae from the blocks of agar. When the slides were placed in the bleaching solution the agar blocks swelled and loosened, leaving only the radiating hyphal strands and chlamydospores on the slide, all in one plane. The standard iron-alum-haematoxylin method was used for staining the nuclei.

[7] Cultures of species of *Sporobolomyces* and *Bullera* were obtained from the Centraalbureau, Yeast Division, Delft, Holland.

It was found that mycelial cells were predominately binucleate, especially during earlier stages of growth. The chlamydospores at first are uninucleate but become binucleate upon formation of the clamp connection on the stalk at the base of the chlamydospore. The two nuclei fuse immediately and the spore assumes the characteristic golden-brown color. Attempts to stain the fusion nucleus in mature spores after complete pigmentation had occurred were not successful. Evidently, special treatment is required to remove

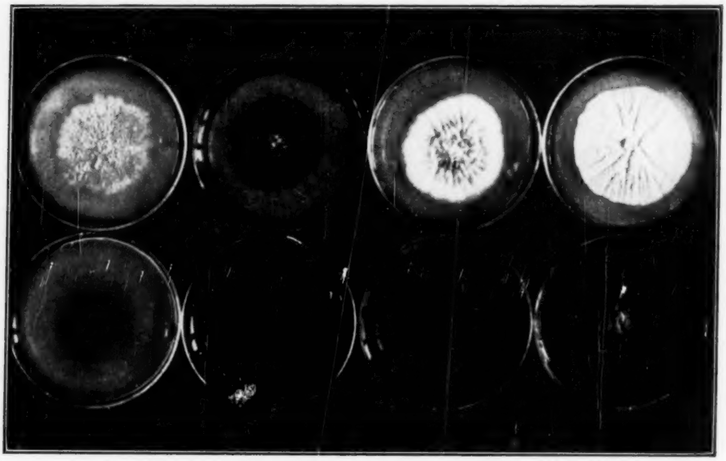

FIG. 5. *Sporidiobolus Johnsonii.* Reaction to various agar media. Upper left to right: Czapek's plus dextrose, Czapek's plus sucrose, Czapek's plus sucrose plus peptone, and Czapek's plus dextrose plus peptone. Lower left to right: Cornmeal, prune, potato dextrose, and malt agars.

oily materials within the spore before the nucleus can be stained in fully pigmented spores.

II. ITERSONILIA PYRIFORMIS

Life History. On nutrient media the ballistospores of *Itersonilia pyriformis* germinate directly to form a mycelium provided with clamp connections at almost every septum (FIG. 6, B). Starting from a single ballistospore, visible colonies are formed within two days at room temperature. Within three or four days ballistospore production begins. The spores can easily be recognized

lying on the agar surrounding the margin of the advancing mycelium. By observing plate cultures under the microscope at low magnification they can also be observed attached to sterigmata which are produced as branches from the mycelium.

The young colonies are raised, rounded, and pure white due to the production of abundant, hyaline, aerial hyphae. As the colony becomes older, the lower surface becomes buff-colored to light tan on malt agar and surface growth becomes appressed.

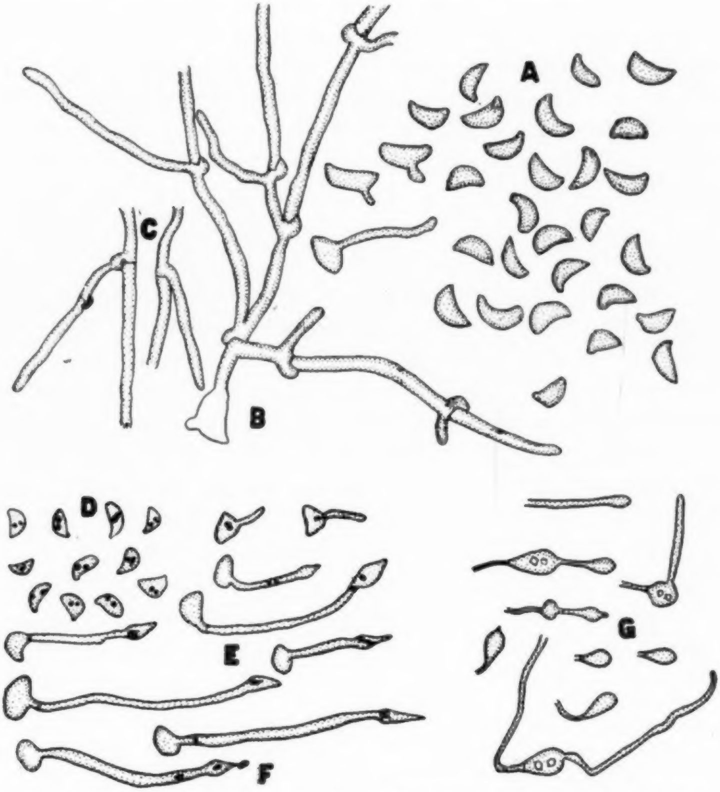

FIG. 6. *Itersonilia pyriformis.* A, Ballistospores; B, Germinating ballistospore showing mycelium and clamps; C, A typical branching arising from clamps; D, Binucleate ballistospores; E, Germinating ballistospores on slide coated with Mayer's adhesive; F, Formation of repeating spore; G, Chlamydospores. Drawn with the aid of a camera lucida. A, B, C, approx. × 500. D, E, F, G, approx. × 350.

When ballistospores germinate on slides that have been coated with Mayer's adhesive, they produce long germ tubes, usually unbranched, each with a swollen spear-point vesicle at the tip. The two nuclei in each ballistospore migrate through the germ tube into the vesicle (FIG. 6, E). Sometimes the germ tube continues vegetative growth but in other cases a secondary ballistospore is formed at the pointed tip of the vesicle (FIG. 6, F) and this spore receives the entire contents of the germ tube, including the two nuclei. Direct production of ballistospores is relatively uncommon on slides containing Mayer's adhesive.

When ballistospores germinate on water agar, either secondary ballistospores are formed directly from the primary ballistospores on short sterigmata, as in *Sporobolomyces* and *Sporidiobolus Johnsonii*, or germ tubes are produced that penetrate downward into the agar. The protoplasm of the germ tube migrates and remains at the growing tip, resulting in complete evacuation of the spore and most of the germ tube. Crosswalls are laid down immediately behind the migrating protoplasm. No clamp connections have been observed under these conditions. On nutrient agar there may be some protoplasmic migration in the germ tube but the tube soon branches and produces a normal mycelium with clamp connections. Germination of the chlamydospores of this species was not observed.

CYTOLOGY. The ballistospores of this species are binucleate in contrast to those of *Sporidiobolus Johnsonii* and those of species of *Sporobolomyces* (FIG. 6, D). Upon germination on nutrient agar they give rise to binucleate mycelia. The nuclei are usually closely associated in the mycelial cells. As far as could be determined the chlamydospores (FIG. 6, G) at maturity are uninucleate, probably containing a diploid fusion nucleus. Considerable difficulty was experienced in getting good preparations of stained chlamydospores.

DISCUSSION

When young cultures of *Sporidiobolus Johnsonii* are observed before mycelial production begins, they cannot be distinguished from some species of *Sporobolomyces*. The masses of ballistospores are pink in color; yeast-like cells are formed and bud exactly as they do in *Sporobolomyces*. Also, the production of bal-

listospores by repetition occurs in the same manner as in *Sporobolomyces*. Single spore cultures were used throughout so there is no question of culture purity.

The ballistospores of *Itersonilia pyriformis* do not exhibit the yeast-like budding nor do they have the pink color of those of *Sporidiobolus Johnsonii*. Also the ballistospores of *I. pyriformis* are larger than those of *S. Johnsonii*. There is considerable difference in the appearance of the colonies of these two fungi when grown on the same medium. *S. Johnsonii* produces an appressed growth with very few aerial hyphae. Also, the colony has a brownish cast due to the masses of brown-walled chlamydospores formed. *Itersonilia pyriformis*, in contrast, produces a luxuriant aerial growth, very white and cottony, at least in young cultures. The chlamydospores formed are thin-walled and hyaline. No clamp connections have been observed in association with the chlamydospores in this species.

Itersonilia perplexans Derx is reported (**3**) to produce "inflated bodies" having clamp connections associated with them. No doubt these inflated bodies, which may be terminal or intercalary, are comparable to the chlamydospores of *Sporidiobolus Johnsonii* and *I. pyriformis*. In *S. Johnsonii* the chlamydospores are thick-walled and brown, being definitely resting spores, whereas, in *I. pyriformis* and *I. perplexans* Derx, they are thin-walled and hyaline. According to Derx (**3**), there is always a clamp connection associated with the chlamydospore of *I. perplexans*. This is also true of *S. Johnsonii* but not of *I. pyriformis*.

The writer is in agreement with Derx (**3**) that Stempell (**7**) probably had a species of *Itersonilia* in culture rather than *Entyloma calendulae* when he described his "Mycel II" and "Halbmondkonidien."

Derx (**3**) has amended the description of the family Sporobolomycetaceae to include the genera *Tilletiopsis* and *Itersonilia*. The genus *Sporidiobolus*, however, has characters that exclude it from the Sporobolomycetaceae. The presence of chlamydospores in which two nuclei fuse would appear to constitute a sexual phase on the order of that occurring in the smuts. Martin (**5**) considers the family Sporobolomycetaceae as being composed of imperfect

fungi and consequently classifies it among the Fungi Imperfecti. *Sporidiobolus* with its apparent sexual stage could not, therefore, be placed in this family.

In the genus description of *Tilletiopsis,* provisionally proposed by Derx (**2**) in 1930 and accepted by him in 1948 (**3**), no mention is made of chlamydospores or of a sexual stage. However, the writer has isolated two species of *Tilletiopsis*[8] which produce chlamydospores that are strikingly similar to those found in the genus *Entyloma.* There is a good possibility that, when the chlamydospores of these two species are studied cytologically, a sexual phase similar to that in *Sporidiobolus* will be revealed. Preliminary work to date has suggested that such will be the case. If so, *Tilletiopsis* could not logically be included in the Sporobolomycetaceae.

As indicated above, the chlamydospores of *Itersonilia pyriformis* contain a single nucleus. The hyphal cells of this fungus are typically binucleate. If further cytological study reveals that the young chlamydospores are binucleate, a sexual stage such as occurs in *Sporidiobolus* would be demonstrated. In that case, neither *Tilletiopsis* nor *Itersonilia* could be included in the family Sporobolomycetaceae as it now stands.

For these reasons, it is considered premature to include the genera *Tilletiopsis* and *Itersonilia* in the family Sporobolomycetaceae of the Fungi Imperfecti as Derx (**3**) has proposed.

SUMMARY

1. *Sporidiobolus Johnsonii,* a new genus and species, is described to accommodate an heterobasidiomycetous fungus isolated from a pustule of *Phragmidium rubi-idaei* (DC.) Karst, in a leaf of *Rubus idaeus* L.

2. A name for a previously undescribed species of *Itersonilia* Derx is proposed for a fungus isolated from a dead leaf of *Acer macrophyllum* Pursh.

3. The life histories, physiology, and nuclear conditions of the above fungi are discussed.

[8] The results of this study will be published in a subsequent paper.

4. The validity of the inclusion of the genera *Tilletiopsis* and *Itersonilia* by Derx in the family Sporobolomycetaceae is questioned.

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PULLMAN, WASHINGTON

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NOTES AND BRIEF ARTICLES

TAPHRINA LATA Palm

In the writer's recent monograph (Univ. Kansas Sci. Bull. **33**: 3–167. 1949) it is stated regarding certain specimens (in the Stockholm Museum) collected by Palm at Tungelsta, Sweden: "It seems highly probable that this is the material Palm used in describing *Taphrina lata*." This fungus is then reduced to synonymy as *Taphrina carnea* Johanson.

Dr. J. A. Nannfeldt has kindly pointed out the probability of error in this treatment of *T. lata*. A reexamination of the material and of the writer's notes makes it clear that the specimens in question must have been those collected by Palm at Tungelsta and called by him (Arkiv. f. Bot. **15** (4): 1–4. 1917) *Taphrina janus*. (*T. janus* is, by the writer's treatment, synonymous with *T. carnea*.) It could not by any possibility be the type material of *T. lata*.

A further error is the writer's report (l.c.) that Palm described *T. lata* as ". . . affecting only young seedlings a foot or less tall." No such statement occurs in Palm's paper (l.c.). Palm described *Taphrina lata* as affecting individual shoots of *Betula pubescens* Ehrh., causing lateral enlargement and slight thickening of leaves, and enlargement of twigs. He distinguished it further by its broad asci: *asci* 40–45 $\mu \times$ 18–22 μ; *stalk cells* 16–20 $\mu \times$ 25–33 μ.

Taphrina lata Palm must be reconstituted as a valid species. Any doubts about it can only be resolved by finding the type material or by collection of material from the type locality.—A. J. MIX, Dept. of Botany, Univ. of Kansas, Lawrence, Kansas.

A NOTE ON INONOTUS AMPLECTENS MURRILL

This very interesting fungus was found and described by William A. Murrill growing on living twigs of *Asimina* in Georgia. On July 28, 1949, Mr. Thomas J. Wesson, Jr., on a field trip found this form growing on the twigs of *Asimina parviflora* (Michx.) Dunal and brought it to the writer who sent it to Dr. J. N. Couch for identification.

On checking the location, this author found this fungus growing on the small papaw along the banks of the Ochlockonee River in Leon county, Florida. The papaws were scattered for 350 feet along the sides of a trail through the dense woods. The fungus occurred on approximately two-thirds of the scattered plants noted. There were 1–4 fruiting bodies per plant.

In a measured space, 15 by 24 feet, 25 knee-high shrubs were counted with an average of 2 thalli per plant. In a second measured area, 15 by 15 feet, 12 waist high papaws were counted with 2–3 fungi per plant.

Inonotus amplectens Murrill usually occurs in the fork of two branches and is attached to both adjacent branches, or to a branch and a leaf petiole. Only occasionally have we found it attached directly to the main stem. Pore surfaces are always oriented so that they project towards the ground. The area of the stem directly under the points of attachment is usually darkened considerably.

It seems to be quite unusual for this fungus to occur in such large quantities. Dr. Herman Kurz who has been collecting in this area for 20 years reports that he has never observed this fungus before this year.—A. W. ZIEGLER, Dept. of Botany, Florida State University.

MYCOLOGIA

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(July 1, 1948–June 30, 1949)

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Subscriptions	3,544.75	
Sale of back sets (vol. 25 and later)	538.00	
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	$6,149.75	
Special funds:		
Sale of back sets (vol. 1–24) and index	$ 185.24	
Interest on endowment	572.00	
	$ 757.24	
Total receipts		$ 6,906.99
Total on hand		$11,587.68
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Engraving	638.15	
	$5,844.52	
Replacing exhausted issues	554.86	
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Total cost		$ 6,871.45
Balance		$ 4,716.23
Unexpended reserve, June 30, 1949		4,716.23
Endowment fund		14,000.00
Total on hand		$18,716.23

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INDEX TO VOLUME XLI *

INDEX TO AUTHORS AND TITLES

* This index prepared by Henry A. Imshaug.

INDEX TO GENERA AND SPECIES

New names, the final members of new combinations, and the page where they appear, are in **bold face type.** Mistakes in the spelling of scientific names encountered in the text are corrected in the index.

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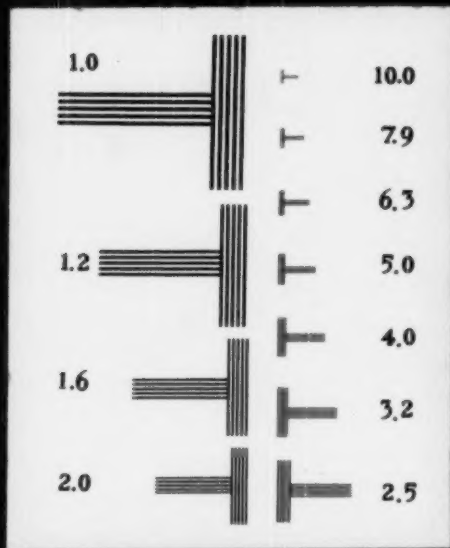

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Examine "T-shaped" line groupings in the film with microscope, and note the number adjacent to finest lines recorded sharply and distinctly. Multiply this number by the reduction factor to obtain resolving power in lines per millimeter. Example: 7.9 group of lines is clearly recorded while lines in the 10.0 group are not distinctly separated. Reduction ratio is 5, and 7.9 x 5 = 39.5 lines per millimeter recorded satisfactorily. 10.0 x 5 = 50 lines per millimeter which are not recorded satisfactorily. Under the particular conditions, maximum resolution is between 39.5 and 50 lines per millimeter.

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